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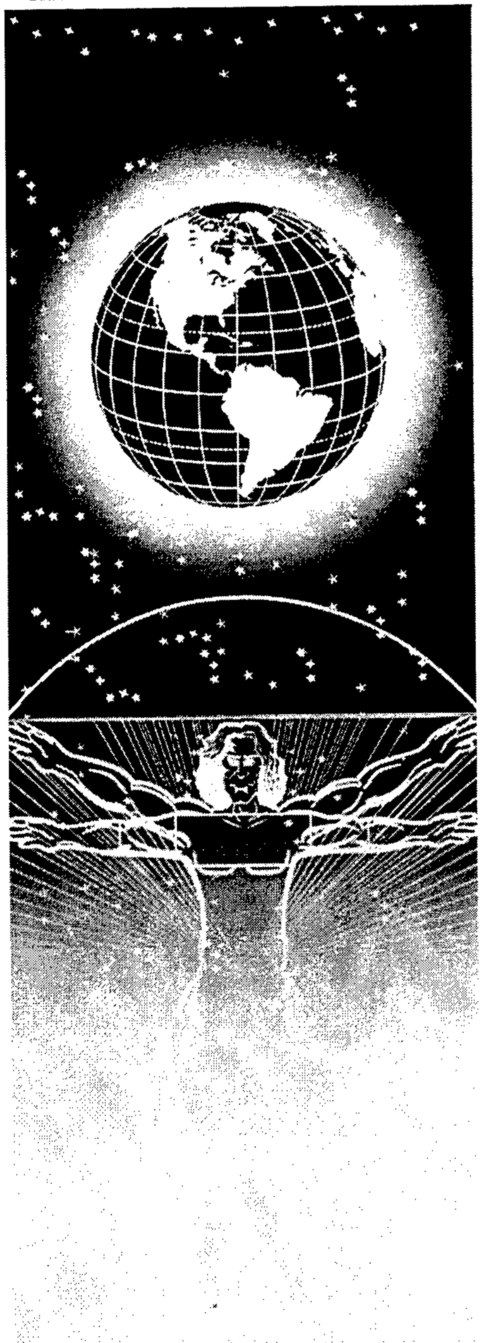

UNITED STATES AIR FORCE RESEARCH LABORATORY

IMAGERY ANALYST WORKSTATION USER-INTERFACE ANALYSIS AND USER-INTERFACE REQUIREMENTS DOCUMENT

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This report has been reviewed by the Office of Public Affairs (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS, it will be available to the general public, including foreign nations.

The voluntary informed consent of the subjects used in this research was obtained as required by Air Force Instruction 40-402.

This technical report has been reviewed and is approved for publication.

FOR THE COMMANDER

JOHN F. KENT, COL, USAF, BSC
Deputy Chief, Crew System Interface Division
Air Force Research Laboratory

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This document describes the approach and method employed in conducting an Imagery Analyst and Intelligence Analyst Workstation Interface analysis and documents the results and recommendations from this analysis including a user interface requirement document for imagery analysis workstations.

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PREFACE

This effort was accomplished with the cooperation of the Air Force Research Laboratory's Human Effectiveness Directorate (AFRL/HE), the Reconnaissance System Program Office (ASC/RAP), National Air Intelligence Center (NAIC), Air Combat Command (ACC) and Science Applications International Corporation (SAIC). SAIC was working in support of the Collaborative Systems Technology Branch, Crew System Interface Division, Human Effectiveness Directorate, of the Air Force Research Laboratory (AFRL/HECI) under contract number F33615-92-D-2293. Mr. David Hoagland (AFRL/HECI) was the Program Manager. This effort supported Work Unit 28302940

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INTRODUCTION

In the past, exploitation of imagery was typically the domain of photo interpreters (PI). PI's would pore over rolls and rolls of film on light tables using magnification and other techniques to extract meaningful information from these images. This process came to be known as imagery exploitation. In today's world of ever-increasing computing power, this process is performed more and more in the digital domain -- and will be performed exclusively in the digital domain in the future.

Computers allow a PI (now more generally known as an Imagery Analyst or IA) to employ an extraordinary number of image manipulation techniques to exploit imagery. Recently, there has also been an increasing proliferation of commercial products that perform these types of functions. Some of these commercial products are legacy products from government or Department of Defense (DOD)-sponsored efforts to develop digital imagery exploitation capabilities, while other products are aimed at more commercial applications. This disparate set of products creates interface standardization problems for the Air Force.

The Aeronautical System Center's Reconnaissance System Program Office (ASC/RAP) was interested in providing the best possible set of user interface requirements for all imagery / intelligence analysis workstations or Electronic Light Table (ELT) systems. ASC/RA consulted with AFRL/HEC to determine which ELT systems were being used, which system user interfaces were most effective for imagery exploitation, and how this information could be integrated into a standard user interface document for this class of workstations.

This document describes the approach and method employed in conducting an Imagery Analyst and Intelligence Analyst Workstation Interface analysis, and documents the results and recommendations from this analysis -- including a user-interface requirements document for imagery analysis workstations. The analysis focus was task-based and concentrated on the imagery exploitation functions performed by Imagery Analysts, as well as similar imagery-related activities of intelligence analysts.

Although the tasking of an IA is somewhat more wide-ranging than that depicted in this report, it was determined early in the project that the effort would be most effective if the approach focused on basic exploitation activities as opposed to other more peripheral tasks an IA may be called on to perform. Therefore, only those activities that directly support image exploitation were considered for this analysis.

METHOD

First, an initial functional decomposition was created from available literature describing IA tasks such as the IA training standards shown in Appendix A. Various techniques were then used to organize this information from the decomposition and literature to provide a basis for interviews with in-house Subject Matter Experts (SME). AFRL's Timeline Management Tool (TMT), a user-centered design tool, was used as the initial data repository for the task decomposition data. The interviews -- initiated to better understand the nature of imagery exploitation and the role of the imagery analyst in this process -- concentrated on the cognitive and perceptual requirements of image exploitation, and attempted to establish the hypothesis-testing nature of imagery exploitation. After several iterations of this process, a representation of IA cognitive task behavior was established. Several Cognitive Task Analysis (CTA)-like methods were leveraged during this process. While these included some cognitive mapping techniques similar to those pioneered by Zaff, McNeese, and Snyder (1993), the most important understanding provided by CTA was the representation of IA task behavior in an abstraction hierarchy similar to that originated by Rasmussen (1986). A depiction of

this hierarchy is found in Figure 1. One of the key benefits of using a cognitive-based approach for this project (as opposed to a more traditional behavioral approach) was that it provided the researchers with insight into the goal-oriented nature of image exploitation. It also provided more insight into the importance of the supporting functions of image exploitation (functions that we classified as orientation or reporting) that do not traditionally receive as much attention as the 'core' exploitation functions (those dedicated to directly extracting information from a scene). Finally, this cognitive-based approach provided some insight into the nature of the more abstract information manipulation activities associated with image exploitation. An example of these activities may be found in the subtle distinction made between a group of targets displayed in an image. When the goal of the exploitation of this image is to simply report each target within this group, the group may be identified as just some enemy tanks or armored vehicles. However, when the goal shifts to evaluation of the threat of this group of vehicles, the identification may change to an enemy tank column that poses a hazard to a friendly unit. The presence of contextual information found in the image scene that allows this kind of distinction may be lost when the goal of the task is not clear.

Decomposition of IA performance began with definition of the overall goals of the IA. Essentially, the IA's job is to extract information from imagery to answer questions posed by intelligence staff. The questions can vary significantly in terms of scope and specificity (e.g., "Is there anything of military significance in this image?" versus "How many and what types of armored vehicles are in this scene?" versus "Confirm or refute the following scenario" versus "What is going on in this scene?"). In all cases, however, the process of the IA's job is the same -- questions to be answered must be translated into information elements to be obtained from imagery, those information elements must be translated into objects and attributes that can be found in a scene, imagery must be evaluated to find and assess the objects sought, and a report must be prepared that applies the results of the imagery evaluation to answer the original questions.

As with much of human performance, speed and accuracy are important attributes of IA performance. Speed relates directly to productivity. Faster image exploitation times lead to greater imagery throughput. Greater accuracy in finding, identifying, and assessing objects in imagery leads to more effective answers to questions.

Figure 1 depicts the three main processes or sub-goals involved in image exploitation. *Orientation* is the process of understanding the requirements of the task (translating the question or questions into objects that must be sought in the imagery), identifying, acquiring, and organizing supplemental resources, and becoming acquainted with the characteristics of the imagery that may provide contextual and / or cultural information. This process is also known as getting *situated*. Orientation includes reviewing the tasking, gathering relevant resources (resources relevant to answering the explicit and implicit questions from the tasking), and organizing those resources in ways that facilitate the information extraction function.

Information Extraction is the process of finding objects in the imagery, and coming to conclusions about the states or intentions of those objects. It is important to note that the term 'object' may refer to groups of detectable entities in an image as well as individual ones, and may also represent abstract entities as well as concrete ones. Information extraction involves the assessment of the context, patterns, and relationships among objects. This process can be considered to contain the 'core' exploitation activities -- those of detection, classification, and identification. That is, information extraction includes object detection, object interpretation, and object analysis.

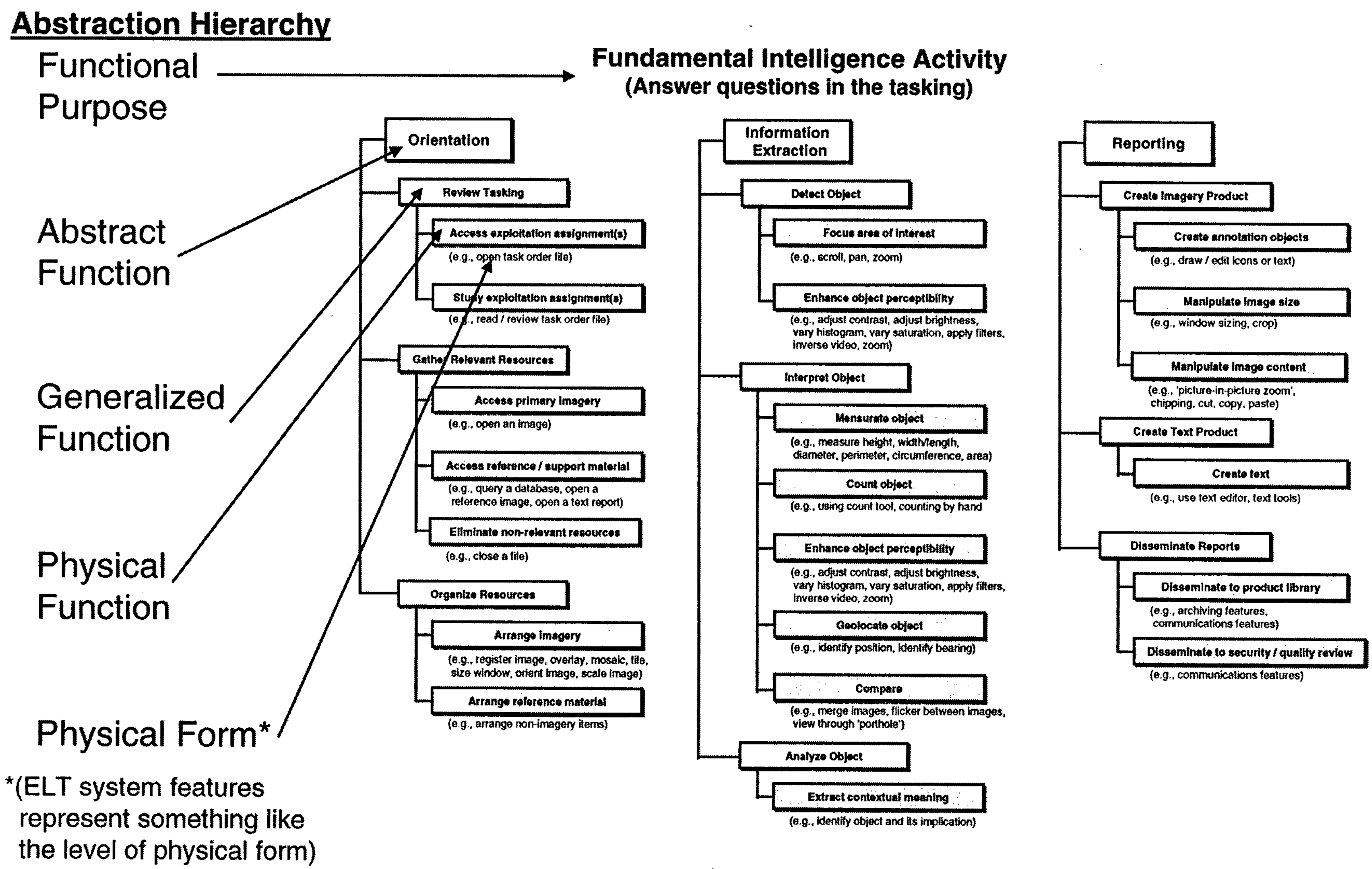

Figure 1. The Imagery Analyst task hierarchy mapped to Rasmussen's (1986) Abstraction Hierarchy.

Reporting is the process of compiling and disseminating conclusions drawn from the imagery. Reporting includes imagery product creation, text product creation, and report dissemination.

An example of how an IA might begin to exploit imagery begins with the IA opening the task order file. This action falls under the physical function of 'access an exploitation assignment' which falls under the generalized function of 'review tasking' and the abstract function of 'orientation' in the hierarchy (see Figure 1). The task behavior then progresses to reviewing the task order to determine the questions that the IA must answer from the imagery. This action falls under the physical function of 'study exploitation assignment', and also under the 'review tasking' generalized function. The IA may then open imagery files pertinent to the task, which falls under the physical function of 'access primary imagery' and the generalized function of 'gather relevant resources'. Then, the IA may mosaic images (supporting the physical function of 'arrange imagery' and the generalized function of 'organize resources') to begin understanding the relevant relationships between the imagery and the questions being asked. All of these actions are considered to support the abstract function of 'orientation', but -- based on the results of the orientation activities -- the IA would proceed to information extraction activities and then, finally, to reporting activities. Any or all of these activities may then be repeated until the question or questions in the task order have been answered and appropriately documented.

Figure 1 also demonstrates how Rasmussen's (1986) abstraction hierarchy maps to the IA task hierarchy. This abstraction hierarchy is a means-ends representation of the functional properties of a technical system. The top of the hierarchy (the *ends* level) represents the purposes or goals for which the system was created. The bottom of the hierarchy (the *means* level) represents the physical manifestation of system goal or purpose. Rasmussen (1986) states that, "Such a hierarchy describes bottom-up what components and functions can be used for, how they may serve higher level purposes, and top-down, how purposes can be implemented by functions and components" (p. 14).

In Rasmussen's (1986) abstraction hierarchy, the lowest level is the level of *physical form*. This level is the most concrete and represents the system in physical appearance and configuration. An example of this level in the imagery exploitation case would be a particular image contrast adjustment tool. The next level up is that of *physical function*. This level represents the physical processes of the system such as -- in the case of imagery exploitation -- object mensuration. The next level is that of *generalized function*. This level represents those system functional relationships that are generally independent of physical manifestation. In this case, object detection is an example. The next level is that of *abstract function*. This level represents the overall organizing principle behind the system. An example in this case is information extraction. At the top of the hierarchy lies the level of *functional purpose*, which -- as mentioned earlier -- is the intended purpose of the system. In this case, it is to answer the questions in the exploitation tasking. In terms of the imagery exploitation system, the three main processes described here represent abstract functions -- while actual software or hardware features exhibited by ELT systems represent the level of physical form.

After the cognitive processes involved with image exploitation had been established, it became important to understand ELT system capabilities -- and how these capabilities support imagery exploitation. Four currently available, in-use ELT systems were selected for a feature cataloguing effort. The ELT packages that were examined were VITec ELT, Paragon ELT 2500, Matrix, and Digital Imagery Exploitation Production System (DIEPS). All of these were software packages that run on UNIX-based X-Windows workstations. Due to limitations in time and availability, all-possible ELT systems were not assessed. However, the four systems that were chosen adequately represent the basic functionality that this project sought to capture. The feature compilation and

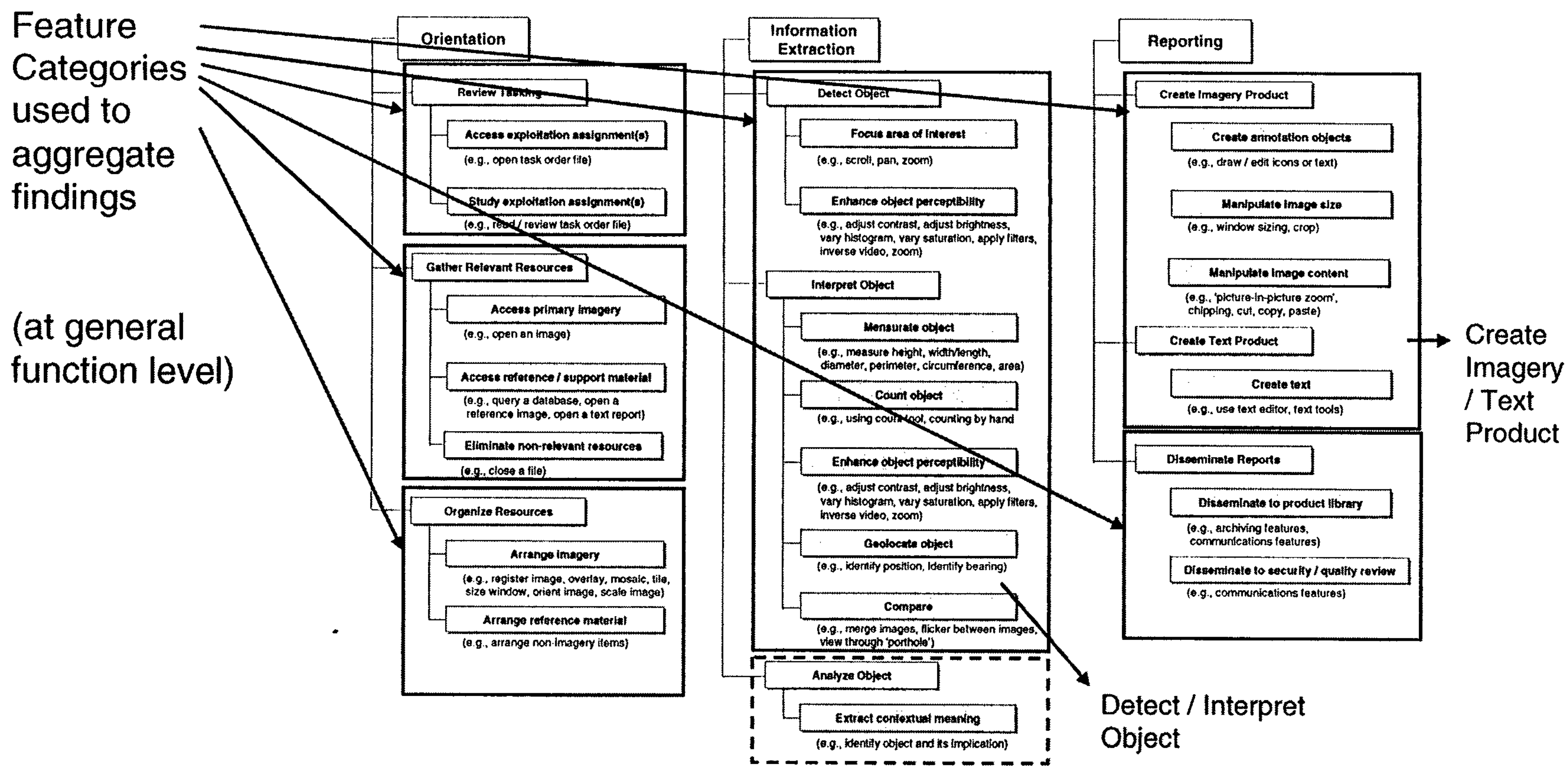

Figure 2. How the feature categories correspond to the hierarchy.

review distilled all of these ELT features down to 110. These 110 features formed the basis for the subjective surveys described later in this document

The ELT system feature compilation effort sought to organize workstation capabilities in terms of functions that supported the process of imagery exploitation. Once the set of possible ELT features had been specified, they were integrated into the IA hierarchy under the nodes that best categorized them. The features were hardware or software instantiations of physical functions (not unlike the level of physical form) and so they represented a linking of the ELT systems to the IA hierarchy. Seven categories of features were later defined to facilitate data analysis and interpretation. These categories are shown in Figure 2.

Essentially, features were categorized by their respective general functions -- except that the 'Detect Object' and 'Interpret Object' categories were combined, as were the 'Create Imagery Product' and 'Create Text Product' categories. These categories were combined to simplify data analysis. Also, note that no catalogued features supported the 'Analyze Object' category.

Data Collection Method

Data collection was a bilateral approach. The first half centered on an actual exploitation exercise, and the second half was a subjective survey. The analysts were asked to perform the exploitation exercise to the best of their abilities using an ELT system (one or several) with which they were most familiar and experienced. Then each analyst separately filled out each section of the survey.

Exploitation Exercise

The main purpose of the exploitation exercise was to provide a situated context for consideration and discussion of ELT system features and capabilities. The second purpose was the opportunity to observe analysts' problem-solving behavior and to allow the opportunity to verify the accuracy of the IA hierarchy. The exploitation exercise was created by SAIC SMEs and staff, and was validated by members of the National Air Intelligence Center (NAIC). The exploitation exercise was built around a fictional scenario that required analysts to review accompanying Synthetic Aperture Radar (SAR) imagery and draw conclusions about certain military activity. The material developed to support the scenario included background information provided to IAs in a paper-based task order package and 22 National Imagery Transmission Format (NITF) images (11 reference images and 11 mission images). Both reference imagery and mission imagery were constructed to provide a story coherent with the scenario. The image files were provided in NITF 2.0 format to facilitate exploitation on all the ELT systems of interest in this study, since all the software packages supported this file format.

The images used in the scenario were constructed by combining separate Synthetic Aperture Radar (SAR) clutter and target images to produce realistic SAR imagery. The separate raw SAR clutter and target images were collected near Huntsville, AL in September 1995 as part of Moving and Stationary Target Acquisition and Recognition (MSTAR) Data Collection #1 conducted by Sandia National Laboratory (SNL) using a SAR sensor platform (see Appendix B). All of the images had a one-foot resolution and were collected at a 15-degree depression angle. The clutter images were collected in a stripmap mode, while the target images were collected in a spotlight mode. Building the scenario began with the examination of the MSTAR clutter imagery to identify the geo-political context for the exercise. Once suitable cultural features were identified by the SME, a plausible story was built around these features. Locations and orientations for armored vehicles in the clutter images were specified by the SME to support the story. Appropriate MSTAR target chips were then selected according to the specifications mentioned previously. SAIC proprietary and commercial

software packages were used to place the selected SAR target chips within the appropriate clutter images.

The scenario was designed to exercise all aspects of the exploitation process including orientation, information extraction, and reporting. This coherent and compelling scenario provided a high degree of realism to the analysts and required them to exercise their detection, interpretation, and analysis skills. It was expected that the analysts would have to read the background information about the scenario, and view and mosaic the accompanying imagery to get oriented to the problem (orientation activity). They would then have to detect, classify, and identify vehicles and building structures found in the imagery and come to certain conclusions about the vehicles or groups of vehicles based on their experience and the scenario's background information (information extraction activity). Finally, they would have to produce imagery and text products that would illustrate the justifications for their conclusions in accordance with the directions in the task order (reporting activity). A copy of the task order package and some examples of the accompanying imagery can be found in Appendix C.

Subjective Survey

The subjective survey incorporated two factors (*utility* and *usability*) for rating purposes, plus a comment solicitation section. An example of the survey may be found in Appendix D.

The *utility* portion of the survey was aimed at evaluating the usefulness of each of the 110 representative features to the exploitation process. Utility was rated on a one-to-five scale, where one was useless to image exploitation, two was slightly useful, three was useful, four was very useful, and five was essential.

The *usability* portion of the survey was aimed at evaluating how well certain ELT systems had implemented these features, i.e., how usable was a particular feature as implemented on a particular ELT system. Usability was also rated on a one-to-five scale, where one represented extremely poor usability, two was poor, three was fair, four was good, and five represented excellent usability. Usability ratings were to be provided by each analyst for as many features of as many ELT systems with which the analyst had experience. Seven different ELT systems were rated on usability for at least some features. The seven were VITec ELT, Matrix, DIEPS, ERDAS Imagine, the Combat Airborne Reconnaissance System's (CARS) Primary Mission Equipment (PME), Harris Corporation's Multi-Image Exploitation Tool (MET), and the Imagery Data Exploitation System (IDEX). This list represents most of the ELT and exploitation systems currently being used within the DOD.

Subjects

Data were collected from various user groups. They were the 30th Intelligence Squadron (IS) at Langley AFB, VA, the 480th Imagery Group (IG) also based at Langley AFB, and the National Air Intelligence Center (NAIC) based at Wright-Patterson AFB, OH.

The 30th IS representing Air Combat Command (ACC) provided four subjects. Their experience levels were 6, 2½, 2, and 1 years, respectively. This group also represented the first phase exploitation community, as most of their tasking is tactical exploitation.

The 480th Intelligence Group (IG) representing the Air Intelligence Agency (AIA) provided two subjects. Their experience levels were 1 and 7½ years, respectively. This group represented the

second phase exploitation community, as most of their tasking was supplemental reporting and the creation of imagery products for further analysis.

Finally, NAIC provided four subjects who validated the plausibility of the scenario, realism of the imagery, and provided comments on the ELT system features. This group represented the third phase exploitation community, as most of their tasking was imagery exploitation with the purpose of gathering Science and Technology (S&T) intelligence.

RESULTS

General Observations

The first general observation from data collection sessions was that the imagery analysts considered the exploitation scenario and the accompanying imagery as very realistic. Almost all of the subjects believed the imagery to be real and most believed that the scenario had actually taken place. This fortuitously lent considerable credibility to the entire effort.

Every subject shifted goal states while exploiting the imagery. That is, every analyst began the exercise with orientation activities, moved to information extraction and reporting, and fluctuated between the three goal states several times during the course of the exercise. As subjects continued to work the exploitation problem, they alternately performed orientation, information extraction, and reporting activities. This task behavior was not unexpected based on the IA hierarchy-predicted task flow outlined earlier.

Orientation activities consumed significant amounts of time when multiple / mosaiced images were involved. This result was also somewhat expected given the lack of 'automatic' mosaicing tools by all of the ELT systems used in the exploitation exercise.

Finally, analysts at the 480th IG used multiple tools to perform the exercise. During certain periods in the exercise, especially during shifts in goal states, these analysts chose to use different ELT systems to perform different functions. These analysts had the luxury of being able to choose from any of the systems evaluated in this study at any time, but it illustrates that none of the existing systems may be best suited for performing all aspects of the exploitation task.

Data Analysis

Results of IA Hierarchy Verification

In order to verify that the IA hierarchy was indeed representative of the way analysts exploit imagery, we tracked IA progression through the exploitation exercise in the context of the hierarchy. For each IA, records were kept on the sequence of activities performed as he or she progressed through the tasking. Task behavior observations were associated with corresponding functions in the IA hierarchy -- from the abstract function level down to the physical function level (see again Figure 1). After examining all of the hierarchy sequences, a composite sequence was built that represents the vast majority of task behavior. This composite sequence is shown in Figure 3.

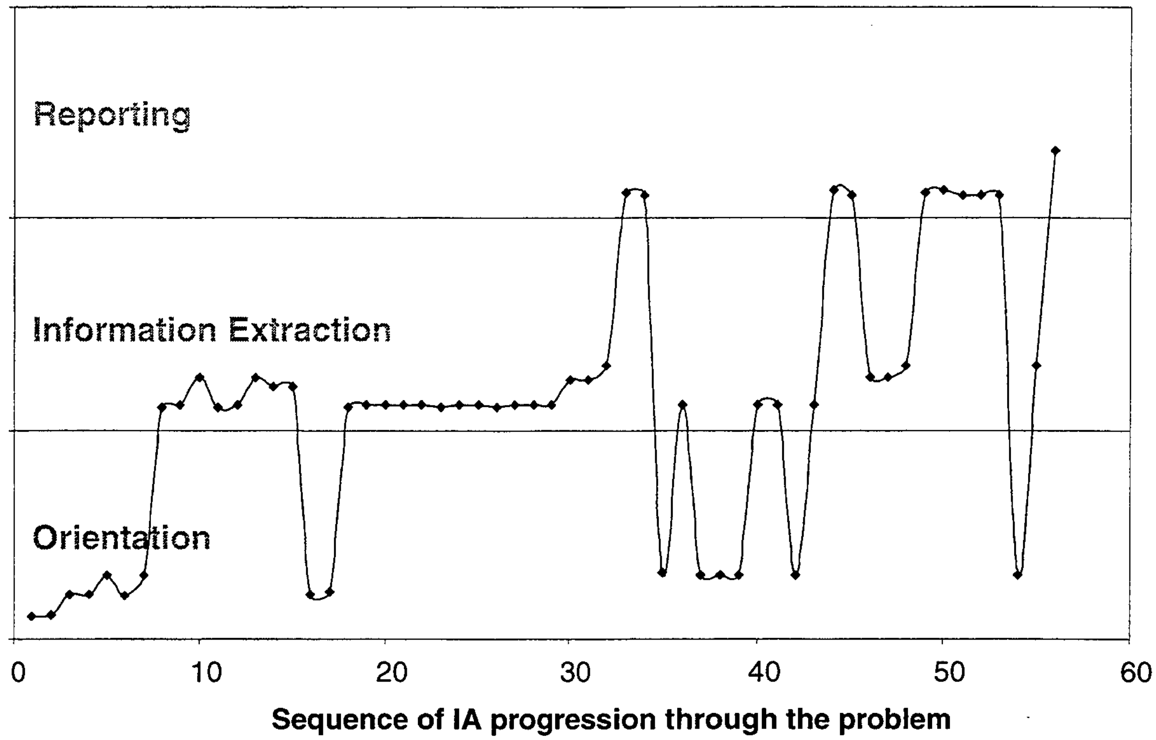

Figure 3. A composite IA cognitive behavior map.

Each physical function was assigned an arbitrary value within that physical function's abstract function and plotted in sequence of performance. This plot shows that IAs do indeed shift goal states and that progression through exploitation is not linear and procedural, but instead is goal driven and dynamic. It also suggests that context is important for driving some of the shifts in the analysts' goal states. Specifically, context refers to the IA's behavior relative to the question or questions being posed and the nature of the imagery. In this case, for example, it is not enough for the IA to simply identify or classify vehicles in the radar imagery. The IA must also determine -- based on the scenario claim that no Soviet tanks have left garrison -- whether or not the Russians are telling the truth. This claim needs to be tested, but that requires far more confidence in vehicle identification than it may otherwise. Also, the fact that the IAs examine SAR imagery carries certain implications for their expectations regarding what one may see in SAR imagery that is distinctly different from visual imagery. These factors affect how the exploitation process is carried out.

Figure 4 is an actual imagery product from the exploitation exercise. The top and bottom images are both mosaics of three separate images each. The top mosaic depicts a certain area as it was on 1 August, and the bottom mosaic depicts essentially the exact same area as it was on 10 August. This demonstrates that the analyst was able to establish the spatial relationships between separate images and the temporal relationships between the mosaics. The annotations in the images also demonstrate object detection activity (which is evidenced by the annotations themselves), object interpretation activity (which can be seen by the annotations that identify certain objects as certain vehicles, e.g., "Probable BTR-70's"), and analysis activity (which can be seen when objects in each scene are identified, not based solely on perceptual characteristics, but through the integration of information only available in the prior reporting package in Appendix C). All of this evidence supports the idea that the exploitation scenario was successful in that it forced analysts to exercise all aspects of exploitation activity.

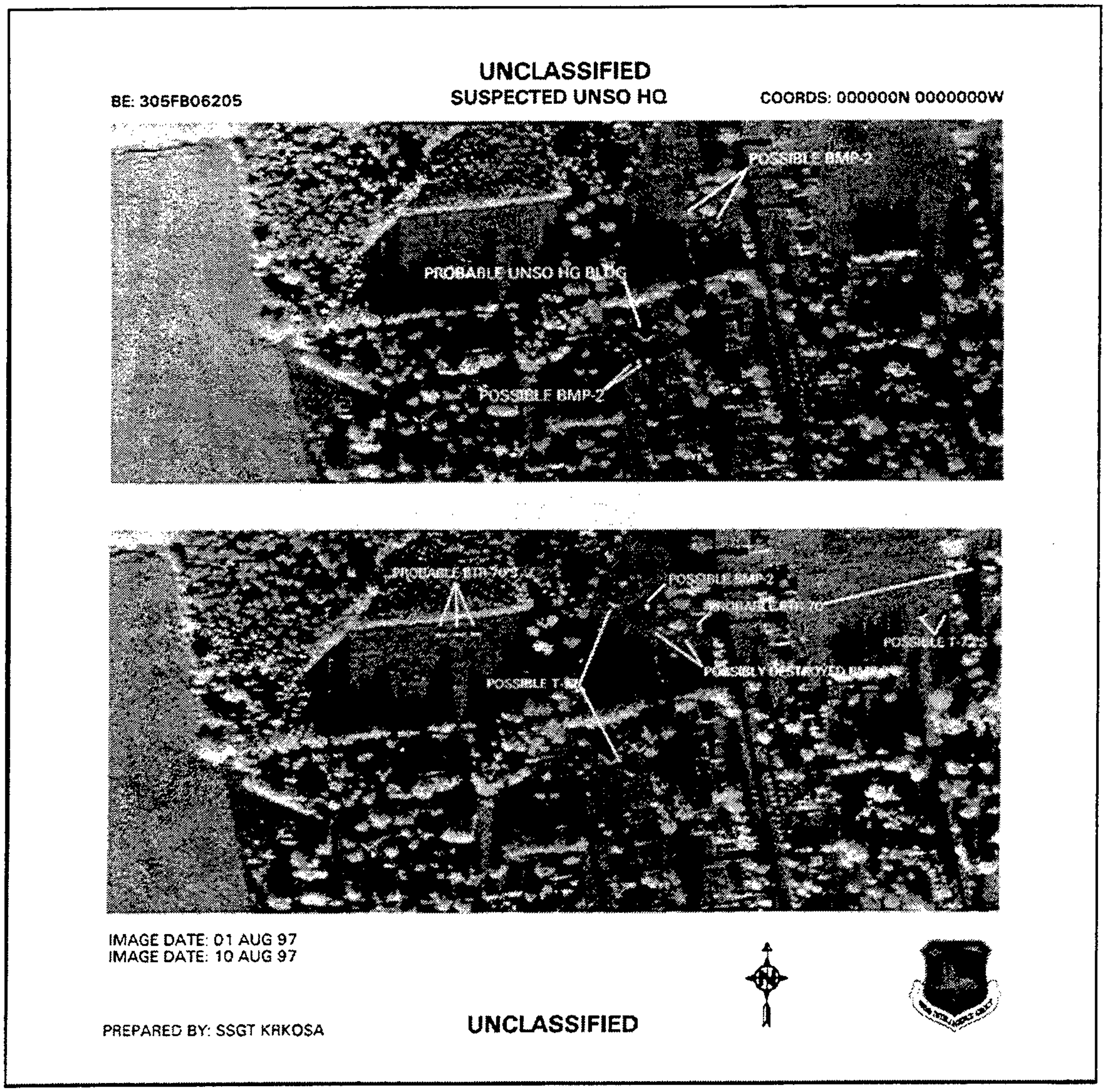

Figure 4. Example imagery product from exploitation exercise.

Survey Results

UTILITY ASSESSMENT

The utility scores were averaged across subjects. Means and standard deviations were calculated by feature, and across features within a feature category. Looking at Table 1, we see that -- on average -- all feature categories were judged more than useful (a mean rating greater than three). This result suggests that IAs perceive that most existing features on current ELT systems are useful and are necessary for the job.

Table 1. Mean utility ratings by feature category.

Feature Category	Mean	StDev	No of Features
Organize Resources	4.18	0.84	19
Disseminate Reports	4.17	0.75	1
Create Imagery/Text Product	4.11	0.88	35
Detect/Interpret Object	4.01	1.02	44
Gather Relevant Resources	3.93	0.92	10
Review Tasking	3.83	0.41	1

An even clearer picture emerges when we consider utility ratings by feature. Figure 5 shows the distribution of utility ratings across all features. Of the 110 surveyed features, 103 were judged to be at least useful (a rating of three or better). In addition, the majority of those 103 features were rated very useful (a rating of four) or essential (a rating of five). The six features rated as essential all deal with navigating through or measuring the image. This result meets expectations since these are classic information extraction related activities.

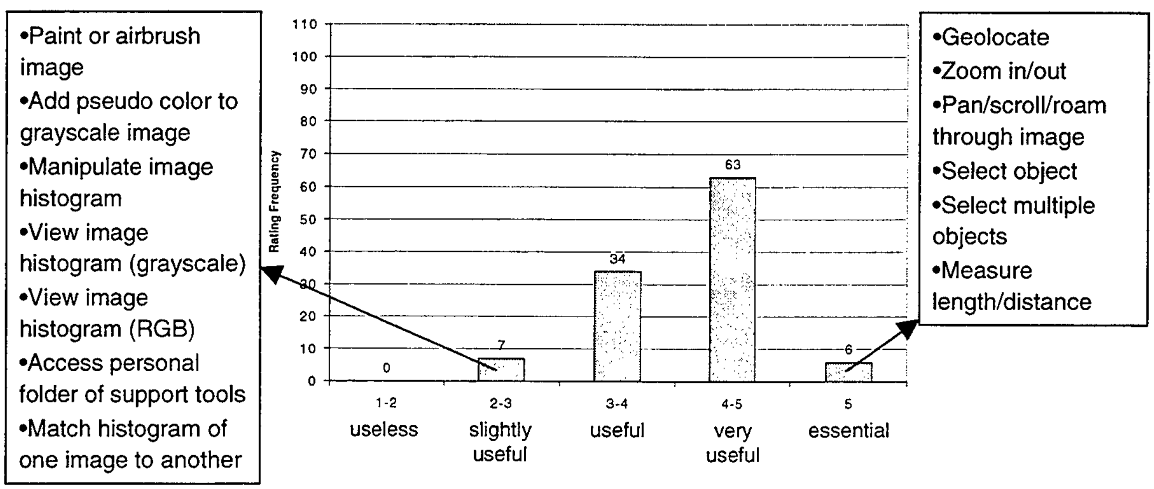

Figure 5. A frequency distribution of utility ratings by feature.

Only seven of the 110 features were not rated at least useful. An examination of those seven showed that four dealt with image histogram manipulation. Effective manipulation of an image histogram that results in a marked improvement in image quality typically requires some time (the extent of which depends on the analyst's level of expertise) and a clear purpose -- with a well-defined path towards that end. Time is at a premium in the tactical exploitation environment, so the analyst who is less experienced with the purpose for, and the technique to adjust, an image's histogram will typically elect not to exercise such a feature. Such a decision can lead to a vicious circle, however, because subsequent iterations of this situation will find the analyst less and less likely to employ histogram manipulation features as he or she has less and less experience with this feature over time. Therefore, these features may yet prove useful under certain conditions -- especially with increased training with them.

The next question that needs to be asked of these data is whether the utility ratings change as a function of mission. Utility rating averages by feature were calculated separately for the 30th and the 480th. Then, the number of features that each unit considered useful (a rating of three or above) was tallied and appears in Table 2.

Table 2. Feature utility ratings for the 30th IS and the 480th IG.

Number of ELT features considered useful (average rating three or greater)	
30th IS	**480th IG**
104/110 (94.5%)	105/110 (95.5%)
Features not considered useful (average rating less than three)	
30th IS	**480th IG**
View image histogram (RGB)	Vary glare
View image histogram (grayscale)	Invert video (negative)
Manipulate image histogram	Add pseudo color to a grayscale image
Access a personal folder of IA support tools	Paint or airbrush an image
Match histogram of one image to another	Access a personal folder of IA support tools
Change the aspect ratio of an image	
Number of useful ELT features that the 30th and 480th have in common	
100/105 (95%)	

Overall, we see that both units considered about 95% of the features as useful. In addition, the units had a 95% agreement on those features which both considered useful. Table 2 also lists those features that each unit did not consider useful. Some minor differences do exist between organizations, but these differences seem to be consistent with the differing missions of these units. For the 30th IS (the organization devoted to tactical exploitation) the least useful features supported object detection and interpretation, but from an image manipulation perspective. Most of these 'least useful features' dealt with histogram manipulation -- functions that are typically used by the S&T community. For the 480th IG (whose mission tends to support more supplementary reporting, rather than just tactical exploitation) the least useful features were again those that supported object detection and interpretation from the image manipulation perspective, but tended to be associated with other missions. For example, an 'invert video' feature tends to be associated with the tactical exploitation community while features such as 'vary glare' and 'add pseudo color...' tend to be associated with the S&T community. Neither unit deemed the feature 'Access a personal folder of IA support tools' as useful.

USABILITY ASSESSMENT

For the purposes of this analysis of usability ratings, it was important to discover which features were given the highest average ratings and which ELT systems were responsible for these ratings. To effect this examination, maximum average usability ratings for each feature were calculated for each ELT system. For each feature, the maximum average usability rating was determined and a maximum-average usability frequency distribution was generated.

As Figure 6 shows, 101 out of 110 rated features were judged to be good or excellent in usability in at least one ELT system. In fact, all rated systems contributed a maximum-average usability rating for at least some of the features.

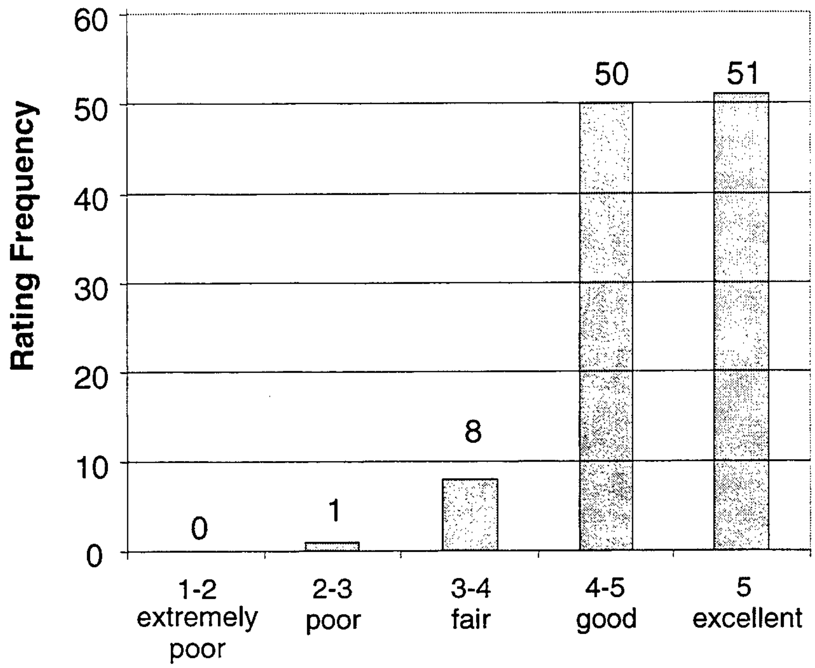

Figure 6. Maximum-average usability ratings frequency distribution across all ELT systems.

The breakdown of ELT systems and maximum-average usability ratings is shown in Figure 7. These two charts suggest that the combination of all the best features of all the ELT systems considered in this study would result in an almost completely effective user interface without resorting to any additional design work. In addition, one could even come to the conclusion that almost all of those features could be copied from only four of the seven surveyed systems. However, despite the obvious wariness that such a statement should create, some other cautionary information should be considered.

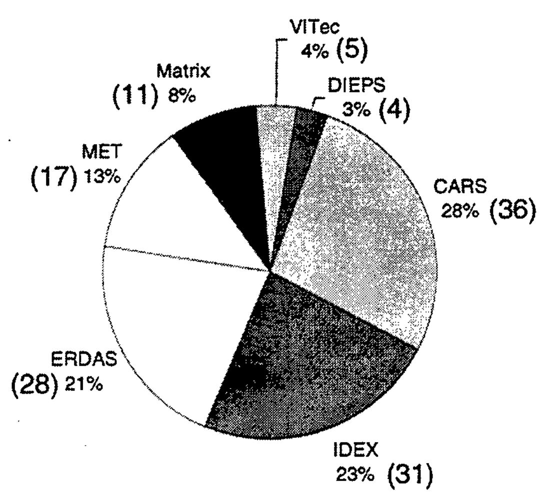

Figure 7. Usability maximum-average ratings distribution by ELT system.

(Note that this chart does not distinguish where multiple systems share the maximum-average.)

Table 3 shows the usability rating coverage for each ELT system. The last two columns in this table are especially important. The "rated features" column shows that, for five systems, mean ratings are based on data from only one or two IAs. Several analysts -- lacking experience with some or all of certain systems -- chose not to rate some or all features of the ELT systems with which they were not experienced. Only the VITec ELT was rated by every analyst on at least some features. The greatest number of analysts rating any feature of any of the other six systems was three. Therefore, only the VITec usability ratings could be considered reasonably reliable. Despite the questionable reliability of the ratings for six of the ELT systems, however, the overall usability results do suggest trends that -- when combined with the utility results -- produce a clearer picture of where efforts should be concentrated in improving ELT user-interface design.

Table 3. Usability ratings coverage for each ELT system.

ELT system	1-2	2-3	3-4	4-5	5	Rated features	# of IAs
VITec	1	22	63	24	0	110	6
Matrix	13	26	27	23	3	92	2
DIEPS	11	25	18	14	1	69	1
ERDAS	0	3	37	61	1	102	3
CARS	8	22	30	26	24	110	2
MET	0	3	13	9	15	40	1
IDEX	20	6	4	11	26	67	1
Totals	53	107	192	168	70		

UTILITY AND USABILITY COMBINED

When utility and usability are reclassified as either high or low and then combined, a matrix emerges that begins to bring the user-interface issue into focus. First, we address the issue of reclassification. For utility, any feature with a mean rating equal to or greater than three was 'useful' and any feature rated less than three is less than useful. Therefore, three was used as the cutoff for low and high utility. For usability, any feature with a mean rating equal to or greater than four had 'good' usability and any feature rated less than four was 'fair' or worse. Therefore, four was used as the cutoff for low and high usability.

Figure 8 represents a sort of priority matrix where each quadrant denotes features requiring greater or lesser attention. The upper left quadrant of the matrix represents high utility and high usability, or those features that are useful and are being implemented well. Ninety-four of the 110 features fall into this category.

Once again, an effective ELT system could be constructed by combining the best features of existing workstations. A list of all features and where they lie in priority with regard to utility and usability can be found in Appendix E.

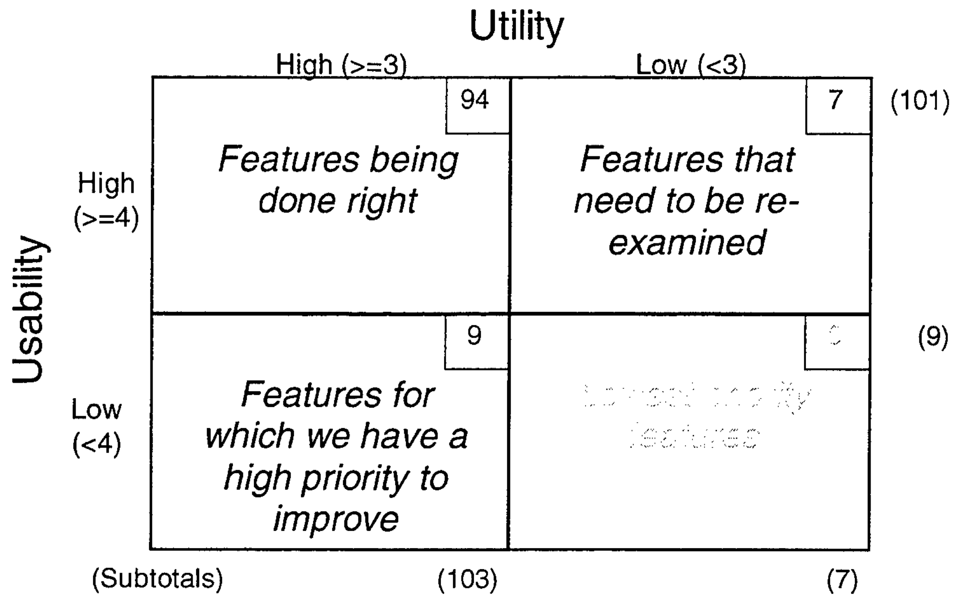

Figure 8. A utility by usability feature priority matrix.

High priority features, or those features that have high utility but low usability, are listed in Table 4. These are features that need to be redesigned, as none of the surveyed ELT systems adequately implement them.

Finally, we have the seven features that need to be re-examined. Again, we see in Table 5 that image manipulation features, especially those dealing with an image's histogram, are deemed by this user community as not very useful. These features need to be re-considered for inclusion in an ELT system.

Table 4. High priority features.

Feature Category	Feature	Mean Utility	Max Usability
Create Imagery/Text Product	Select all objects	4.33	3.60
Detect/Interpret Object	Enhance SAR image (e.g. streak removal)	4.17	3.00
Detect/Interpret Object	View Accuracy Log (with estimated accuracy of mensuration results)	4.17	3.25
Gather Relevant Resources	Import a file from an external database	4.17	3.83
Gather Relevant Resources	Display any comments associated with an image (comments that are not part of image or overlay)	4.00	3.75
Gather Relevant Resources	Open a reference map for an image	3.83	3.50
Organize Resources	View image status/history	3.67	3.75
Detect/Interpret Object	View Image Through Porthole	3.00	2.00
Organize Resources	Change the Aspect Ratio of an Image	3.00	3.00

Table 5. Features needing re-examination.

Feature Category	Feature	Mean Utility	Max Usability
Detect/Interpret Object	View image histogram (RGB)	2.83	4.00
Detect/Interpret Object	View image histogram (grayscale)	2.83	4.00
Detect/Interpret Object	Add pseudo color to a grayscale image	2.83	4.00
Create Imagery/Text Product	Paint or Airbrush an Image	2.83	4.17
Detect/Interpret Object	Manipulate image histogram	2.83	5.00
Gather Relevant Resources	Access a personal folder of IA support tools	2.67	4.00
Detect/Interpret Object	Match histogram of one Image to another	2.67	5.00

SUBJECT COMMENTS

Comments were collected in order to better interpret the more objective results. The comments overwhelmingly took the form of suggestions for feature improvements or new features. The two comments / suggestions that stood out the most were (1) implementation of a multi-level 'undo' feature, and (2) improved mensuration accuracy. Almost all analysts want the capability to back out of an action or a series of actions. Further, most analysts desire dramatic improvement in mensuration accuracy. The remainder of the suggestions took on slightly less urgency, but they were considered important nonetheless. A large image working area was considered desirable, and the ability to see the big picture while scanning details (such as a roam feature with an overview displayed with the historical track of the roaming activity) was desired. Also, when two images that are temporally related are loaded together, analysts wanted to have the cursor displayed in both images simultaneously -- thereby allowing simultaneous actions (such as zooming) to be performed on both images. Many analysts desired a much more fine-grained adjustment of zoom than most systems currently support. Also, many desired better annotation capabilities, but were not specific as to how they would improve existing systems. Finally, almost all analysts wanted the capability to customize ELT workstation setup to their own preferences.

DISCUSSION

Although much discussion has already been provided in the results section, some overall conclusions are offered here as a summary. First, utility results suggest that, taken together, current ELT systems provide most of the functionality needed by the IA community. These results are further supported when usability is also considered. However, no one ELT system currently provides all required functionality or adequate implementation of that functionality.

Based on the current results, almost all of the rated features should be included in any future ELT system design. Overall ratings, however, suggest that some features should be discarded (see again Table 5). However, these are features that appeal to the S&T exploitation community; their inclusion may not be in question, but perhaps they should be de-emphasized in configurations aimed at tactical exploitation. Another interpretation of these low utility and usability ratings could be that none of the current ELT systems do a good job implementing these features, and that the poor implementations led to less usefulness.

There is also a need for flexibility based on mission and individual preference. Inexperienced analysts were very unsure of their information extraction capabilities. For example, several IAs expressed uncertainty when attempting to identify targets as tanks versus armored personnel carriers -- despite the high resolution (one-foot) and clear quality of the SAR imagery. Since most of these

analysts actually performed well during the exercise, this lack of confidence might suggest that analysts don't get enough training where ground truth is known and reliable feedback on accuracy of assessments can be obtained.

Most current systems seem to do an adequate job of supporting IA requirements while performing activities that support information extraction, but several features could use improvement in usability. Some of the areas not particularly well supported by existing systems are some aspects of orientation (such as translating the requirements of the task order into an effective exploitation plan) and of reporting (such as an integrated approach to object annotation).

Some new interface concepts to address some of these deficiencies are listed below.

- Contextual functionality (not unlike context-sensitive help)
- Customizable user configuration profiles
- Integration of target annotation and reporting
- On-line target keys

Contextual functionality is functionally similar to context-sensitive help in that it would allow the user to specify the actions carried out by certain controls (such as mouse buttons), as a function of which mode the user was in. For example, under certain conditions, the left, middle, and right mouse buttons may control window navigation or file management, but when using the zoom feature, these buttons would control the degree and directionality of the zoom feature. Some of this capability is already resident in these systems, mostly due to X-Windows conventions. Notwithstanding that, more integration of this kind of capability directly into exploitation systems together with the ability for users to individually specify attributes of this capability is desired.

Customizable user configuration profiles may be likened to user preferences, but extend the concept somewhat. Rather than just storing a set of initialization variables for particular functions, this function would allow users to save individual feature-usage preferences -- as well as their operation preferences -- at higher levels. For example, a user would be able to specify zoom feature functionality as specific to him or her. From a different perspective, a user would be able to configure the layout of toolbars and menus according to personal preference by mission (e.g., configuration x for tactical exploitation with SAR imagery and configuration y for S&T exploitation with electro-optical (EO) imagery). In addition, these kinds of preferences could then be tied together in combinations when the need arises.

Integration of target annotation and reporting and on-line target keys are depicted in Figure 9. In the figure, we see the IA diligently exploiting some SAR imagery. The IA begins by opening his 'smart' task order, which has already electronically cued various imagery and text report searches for the relevant files he needs. After the IA reads the task order questions, he opens relevant imagery files in order to orient himself. As he opens the images, the system immediately plots them on 'oil stock' or vector maps and affixes collection time tags to each image. The IA then begins to group various images together in mosiacs by simply selecting the individual images and saving the collections as objects.

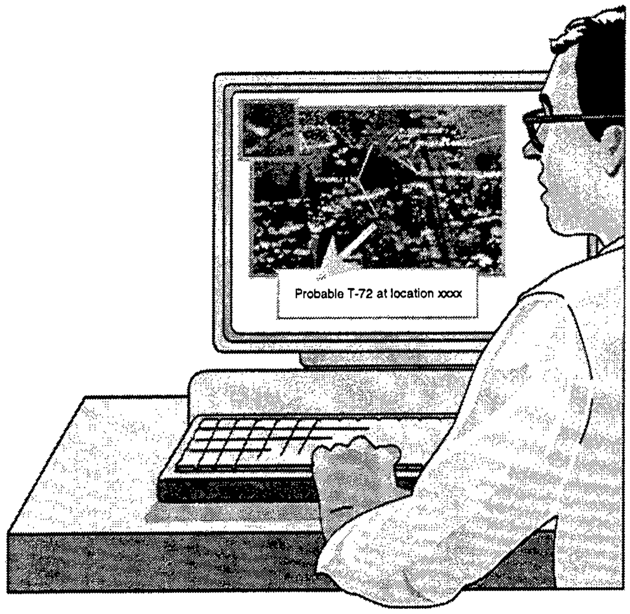

Figure 9. Integrating two new interface concepts.

After defining the various imagery objects, he begins the target detection and identification process. To help the IA make the correct identifications so critical to the accuracy of the subsequent report, on-line target keys would be available to assist him. The keys would work by displaying what different targets may look like based on known imagery and environmental attributes. For example, if the IA suspected a target as being a BMP-2 armored personnel carrier (APC), he could ask the target key module to provide an image chip that would look like that target in a certain orientation. The module would handle the calculation of this image chip by taking into account known attributes of the sensor (such as resolution and depression angle) and target reflectivity models, to simulate the SAR return of a BMP-2 under the current conditions. The keys would work as primers to the imagery analyst's own pattern recognition abilities -- as opposed to a true automatic target recognition (ATR) system.

As the IA annotates the imagery, target identification data and location data are automatically compiled into a text report template without the IA having to manually generate the text report later. The annotation data could also feed a database in near real-time that would roll up to battlefield or theater situation awareness displays at the higher command levels.

Appendix F describes the user-interface requirements for an ELT system that would support the Air Force intelligence mission through quick and effective imagery exploitation. Such a system would support the three main areas of imagery exploitation (orientation, information extraction, and reporting), and provide the Air Force imagery / intelligence analyst with the most effective toolset for the exploitation of all types of digital imagery.

These types of interface improvements are all within the scope of current or near-term technologies. The actual exploitation-performance benefits that would be derived through application of these concepts remains a topic for further study.

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GLOSSARY OF ACRONYMS

APC	Armored Personnel Carrier
ASCII	American Standard Code for Information Interchange
ATR	Automatic Target Recognition
BE Number	Basic Encyclopedia Number
C3	Command, Control, and Communications
C4I	Command, Control, Communications, Computers, and Intelligence
CARS	Combat Airborne Reconnaissance System
CITC	Community Imagery Training Council
CTA	Cognitive Task analysis
DARPA	Defense Advanced Research Projects Agency
DIEPS	Digital Imagery Exploitation Production System
D/I/T	Detect / Identify and Type
DOD	Department of Defense
ELT	Electronic Light Table
ESD	Exploitation Support Data
GIF	Graphics Interchange Format
GIS	Geographic Information System
HC	Hardcopy
IA	Imagery Analyst
IDEX	Imagery Data Exploitation System
IMINT	Imagery Intelligence
INTEL	Intelligence
JPEG	Joint Photographic Experts Group
MET	Multi-Image Exploitation Tool
MSTAR	Moving and Stationary Target Acquisition and Recognition
NAIC	National Air Intelligence Center
NIIRS	National Image Interpretability Rating Scales
NITF	National Imagery Transmission Format

OB	Order of Battle
PI	Photo Interpreter
PME	Primary Mission Equipment
S&T	Science and Technology
SAR	Synthetic Aperture Radar
SC	Softcopy
SIGINT	Signals Intelligence
SME	Subject Matter Expert
SNL	Sandia National Laboratory
TIFF	Tagged Image File Format
TMT	Timeline Management Tool
UTM	Universal Transverse Mercator

APPENDIX A: ENTRY LEVEL IA TRAINING STANDARDS

1. The imagery functional manager has approved the following entry-level imagery analyst (IA) training standards adopted by the Community Imagery Training Council (CITC) at the 7 November 1996 meeting. These skills were derived from a detailed corporate analysis of current IA tasks common across the IA workforce, by CITC subcommittees. All organizations that provide entry-level instruction, or participate in the development or implementation of on-the-job training programs are to immediately enact these standards in their course curriculum.

2. The training standards listed in paragraphs 3 through 5 relate to required core IA skills. The standards specify 'what' IAs must understand or be able to perform, but now 'how' the skills are acquired. As such, entry-level skills are not intended to equate to particular courses of instruction, but provide total flexibility to imagery training programs in the timing and method of training delivery. Thus, skills taught by one organization in a classroom could be taught through on-the-job training (OJT), mentoring or self-study, or by other organizations. Skills are categorized functionally by 'knowledge' or 'performance'. Each has an associated required competency level.

a. The knowledge competency levels are:

(1) KB = demonstrate basic facts and concepts

(2) KD = demonstrate detailed understanding

(3) SK = function as a subject matter expert

b. The performance competency levels are:

(1) PS = perform task while supervised

(2) PU = perform task unsupervised

c. The core skills discussed in paragraphs 3 through 5 are not intended to convey priorities of importance or to suggest training topic sequence.

3. Entry level IA exploitation core skills.

a. Category: Understand intelligence (INTEL) community, imagery community, imagery security. Core skills and competency levels are:

(1) awareness of INTEL community roles / responsibilities (KB)

(2) awareness of history of imagery intelligence (IMINT) and reconnaissance (KB)

(3) identify current types of sensors and platforms (KB)

(4) identify and define elements of the intelligence cycle and imagery cycle (KB)

(5) understand / use info security procedures (KB, PS)

(6) understand / use physical security procedures (KB, PS)

(7) understand / use imagery security policy and procedures (KB, PS).

b. Category: (Tools) Exploit hard copy (HC) imagery. Core skills and competency levels are:

(1) operate light table functions (PU)

(2) set up light table for different types of HC imagery (PU)

(3) adjust light table optics (PU)

(4) use universal reference grid to locate objects and determine grid locations (PU)

(5) set up HC imagery for stereo viewing (PU).

c. Category: (Tools) Exploit soft copy (SC) imagery. Core skills and competency levels are:

(1) use basic workstation functionality (PU)

(2) display and manipulate SC imagery on a workstation (PU).

d. Category: (Tools) Use exploitation support data systems. Core skills and competency levels are:

(1) identify IA task assignments, priorities and suspenses from data base (PU)

(2) identify IA task external environment interface (EEI), security and releasability requirements from data base (PU)

(3) identify imagery history of coverage by target and geo-reference from database (PU)

(4) identify previous target and topical imagery reports from database (PU)

(5) determine image suitability for assigned IA task (PU)

(6) determine predicted imagery coverage (PS)

(7) determine available collateral data (PS)

(8) extract activity normalcy and deviation reporting tolerances from database (PU)

(9) determine map and geographic information system (GIS) references (PU)

(10) determine direction of an image using data system and image titling (PU)

(11) utilize exploitation support data (ESD) and mensuration support data (MSD) (PU)

(12) create a formatted IA target report (PS)

(13) create a formatted IA topical report and a free text IA report (PS)

(14) create an annotated imagery product (HC and SC) (PS)

(15) locate and extract imagery from a HC image library (PU)

(16) locate and extract imagery from a digital SC image library (PU)

(17) distribute a HC image product to a customer (PS)

(18) disseminate electronically a SC image product into a digital image product library / archive and to a customer (PS).

e. Category: Use basic exploitation techniques, (HC and SC) using optical, radar, and infrared (IR) imagery. Core skills and competency levels are:

(1) determine image National Image Interpretability Rating Scales (NIIRS) rating (KB, PS)

(2) determine NIIRS rating needed to accomplish an IA task (PS)

(3) determine dimensions of an object on imagery using local control (PS)

(4) determine dimensions of an object on HC imagery using image scale and a reticule (PS)

(5) determine dimensions and geo-location of an object on SC imagery and a reticule (PS)

(6) use latitude and longitude to locate points on map (PS)

(7) use Universal Transverse Mercator (UTM) to locate points on a map (PS)

(8) use maps and map symbology to extract data (PS)

(9) correlate a specific point on a map with the same point on an image (PS)

(10) explain differences between physical and cultural geography (KB)

(11) determine elevations on a map using contour lines (PS)

(12) detect, identify, and classify an object on imagery using an imagery key (PS)

(13) understand and use image-titling data (KB, PS)

(14) understand perspective and obliquity on an image (KB)

(15) use the "5 Ss"(size, shape, shadow and surroundings) and give examples of each (PS)

(16) understand and use techniques for searching imagery (KB, PS).

f. Category: Perform imagery interpretation and analysis (HC and SC) using optical and radar imagery; be familiar with basic terminology / nomenclature of equipment and organizations observed on imagery. Core skills and competency levels are:

For geography, transportation:

(1) detect / identify road, rail, air and water surface transportation (PS)

(2) understand relation between geography and military capabilities (KB)

(3) understand relation between geography and military capabilities (KB)

(4) use terrain analysis concepts to identify avenues of approach and barriers to mobility (PS)

For naval order of battle (OB):

(1) detect / identify and type (D/I/T) naval and merchant shipping and storage facilities (PS)

(2) D/I/T and class surface combatants, submarines, merchant ships and auxiliaries (PS)

(3) determine naval OB normalcy, status and changes (PS).

For missile OB:

(1) D/I/T missiles, missile launchers (mobile, silo, fixed, and space), missile canisters and missile support systems (PS)

(2) D/I/T missile bases and support facilities and infrastructure (PS)

(3) D/I/T missile field deployments (PS)

(4) D/I/T mobile missile test facilities (PS)

(5) determine missile OB normalcy, status, and changes (PS).

For air OB:

(1) D/I/T aircraft, including helicopters and naval air (PS)

(2) D/I/T airfields, air facilities, air delivered weapons and weapons canisters, crates and storage facilities (PS)

(3) D/I/T air related ground support equipment (PS)

(4) determine air OB normalcy, status, and changes (PS).

For C4I / electronics:

(1) D/I/T fixed C3 equipment and sites, including microwave, high frequency (HF), low frequency (LF), etc. (PS)

(2) D/I/T mobile C3 equipment, deployed and in garrison (PS)

(3) D/I/T fixed radar equipment and sites (PS)

(4) D/I/T mobile radar equipment, deployed, and in garrison (PS)

(5) determine C4I / electronics normalcy, status and changes (PS).

For ground OB:

(1) D/I/T ground forces equipment, including tanks, APCs, artillery, multiple rocket launcher systems (MRLS), wheeled and tracked transports (PS)

(2) D/I/T engineer equipment, tactical air defense equipment, and tactical missile systems (PS)

(3) D/I/T chemical, biological and radiological warfare equipment (PS)

(4) identify ground forces training areas, obstacle courses, active and passive defenses, obstacles and barriers (PS)

(5) identify major ground force facilities and infrastructure including barracks, headquarters areas, munitions and fuel storage areas (PS).

For industry:

(1) identify the major categories of industry. (i.e., mining, factories, power production and service) (KB, PS)

(2) identify military related industries, especially production and testing of major weapons systems (PS)

(3) identify industrial components (i.e., supply yards, fabrication buildings, substations, loading docks) (KB, PS)

(4) identify production, testing and storage facilities for weapons of mass destruction (PS)

(5) determine industrial normalcy, status, and change (PS).

Additional areas:

(1) identify denial and deception activity (PS)

(2) identify capabilities of different sensors and platforms to defeat defense in depth (KB)

(3) perform damage analysis (PS)

(4) identify weapons effects data (i.e., use DOD publications) (PS)

(5) identify sensor advantages and limitations for damage analysis (KB).

4. Entry level IA collection-related core skills.

a. Category: Imagery sensor capabilities and limitations. Core skills and competency levels are:

(1) identify basic capabilities of current sensors and platforms, including literal vs. non-literal imagery; sun-synchronous vs. non-sun-synchronous platforms (KB)

(2) identify capabilities and limitations of current sensors and platforms (KB)

(3) identify impact of vehicle attitude on NIIRS, target size, and collection competition (KB)

b. Category: Imagery requirements management procedures and terminology. Core skills and competency levels are:

(1) understand community role in developing imagery priorities (KB)

(2) identify differences between routine nominations and ad hoc nominations (KB)

(3) understand differences between priority and immediate ad hoc nominations, including approval process and duration of collection (KB)

(4) understand role of the requirements manager, including nominations research and nominations submission (KB)

(5) understand types of imagery targets and the associated collection implications (KB)

5. Entry level IA imagery processing-related core skills.

a. Category: Optics and imaging. Core skills and competency levels are:

(1) identify concept of the electromagnetic spectrum-(KB);

(2) identify basic concepts of optics and optical characteristics-(KB);

(3) identify basic collection sensor concepts and characteristics-(KB).

b. Category: Photographic processing (HC). Core skills and competency levels are:

(1) identify basic terminology and functional concepts of conventional photo processing, including duping, printing, enlarging, emulsions-(KB);

(2) read HC film titling-(PS);

(3) demonstrate proper film handling procedures-(PS);

(4) understanding that there is a process for requesting photo lab services-(KB).

c. Category: Digital imagery processing (SC). Core skills and competency levels are:

(1) identify basic terminology and functional concepts of digital imagery processing-(KB);

(2) demonstrate operation of a digital workstation, including adjusting display and doing digital printing-(PS);

(3) understand basic concepts of primary and secondary electronic imagery dissemination, including dissemination, including communications considerations-(KB);

(4) understand basic procedures for scanning images-(KB).

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APPENDIX B: MSTAR DATA COLLECTION

A Moving and Stationary Target Acquisition and Recognition (MSTAR) program data set was collected in September of 1995 at the Redstone Arsenal, Huntsville, AL by the Sandia National Laboratory (SNL) "STARLOS" SAR sensor platform. The collection was jointly sponsored by DARPA and Wright Laboratory as part of the MSTAR program. SNL used an X-band SAR sensor in one foot resolution spotlight mode. Strip map mode was used to collect the clutter data.

A subset of the data from the September 1995 collection has been identified by DARPA and Wright Laboratory for public release.

For more information on the MSTAR imagery and tools, the reader is directed to the MSTAR project portion of the Sensor Data Management System (SDMS) World Wide Web site at http://www.mbvlab.wpafb.af.mil/public/sdms/main.htm or by electronic mail at cd_help@mbvlab.wpafb.af.mil.

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APPENDIX C: EXPLOITATION SCENARIO TASK ORDER

Possible Russian Peacekeeping Operation Violations in Abkhazia

Background

During the past year, Georgian and Abkhazian relations have continued to be volatile. Following the 1992-1993 fighting, which was met by Russian Peacekeeping Operations (PKO), hostilities have been intermittent. Russian forces in the area have been reported to range from 700-1200 including the 901st Air Assault Battalion and the 901st Motorized Rifle Regiment (Provisional). Russian forces remained following the 1992 occupation, as there have been six separate cease-fire agreements, all of which have been violated by one or more parties. The Russian PKO now tends to be comprised of a largely Abkhazian descendent force and, therefore, has emotional ties to the local population.

The Abkhazians have been increasingly more adamant for sovereignty from Georgian rule. The Ukrainian National Self-Defense Organization (UNSO) has recently become more active in supporting the Georgian political leadership in conducting operations against the Abkhazian capitol city of Sukhumi. Reports from Sukhumi indicate the UNSO have infiltrated an area in the northeast section of the city and have between 200 and 500 troops equipped with small arms, BMP-2 armored vehicles, and are possibly in possession of chemical devices. Recent HUMINT indicated they intended to poison the area's sole fresh water supply - a large reservoir north of the capitol city - on or about 3 August 1997.

Russian forces were deployed from the provisional garrison area to disperse the UNSO activity. The Russian force was to serve only as PKO and not take open action against the UNSO. Reports from the Georgian government indicate the Russian forces may have attacked the UNSO operations center with armored infantry and T-72s, possibly destroying two BMP-2s and driving the remaining forces to the west. According to the Georgian government, the Russian forces, "savagely attacked peaceful UNSO supporters killing over 100 civilians and destroying several government buildings and homes." Russian military leaders in Sukhumi state that no tanks have left garrison and their only action has been to defend the reservoir from possible contamination.

The Georgian and Ukrainian governments have made a plea to the Russian President to recall the forces and have asked the United Nations (UN) to investigate the alleged actions by the Russian forces. The area of interest had only sparse IMINT coverage during the time of these actions. No emphasis was placed on collection or reporting as these actions were viewed of little impact at the time. The UN has asked the data be reviewed for indications of possible Russian offensive actions.

Reporting Requirements

Provide annotated imagery of any unusual activity such as: deployment of armor (number and type), indications of actions against fresh water supply, battle damage, and any significant military operations.

Generate summary intelligence report (1 short text report w/ annotated support imagery).

Support Material

Imagery

Reservoir and suspected UNSO operations center imaged two days prior to alleged UNSO threat to poison water supply. Coverage of provisional garrison area acquired three and five days following threat. Reservoir and UNSO operations center reacquired seven days following threat.

The following 1-foot SAR imagery products are provided. (The STARLOS sensor with a 15-degree depression angle collected this imagery.)

Filename	BE number	Acquisition Date	Description
62050801.NTF	305FB06205	01-Aug-97	Suspected UNSO HQ (frame 205)
62060801.NTF	305FB06206	01-Aug-97	Suspected UNSO HQ (frame 206)
62070801.NTF	305FB06207	01-Aug-97	Suspected UNSO HQ (frame 207)
62370801.NTF	305FB06237	01-Aug-97	Sukhumi Reservoir (frame 237)
62380801.NTF	305FB06238	01-Aug-97	Sukhumi Reservoir (frame 238)
62390801.NTF	305FB06239	01-Aug-97	Sukhumi Reservoir (frame 239)
62400801.NTF	305FB06240	01-Aug-97	Sukhumi Reservoir (frame 240)
61810806.NTF	305FB06181	06-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 181)
61820806.NTF	305FB06182	06-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 182)
61830806.NTF	305FB06183	06-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 183)
61840806.NTF	305FB06184	06-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 184)
61810808.NTF	305FB06181	08-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 453)
61820808.NTF	305FB06182	08-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 454)
61830808.NTF	305FB06183	08-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 455)
61840808.NTF	305FB06184	08-Aug-97	901st Motorized Rifle Regiment Provisional Garrison (frame 456)
62050810.NTF	305FB06205	10-Aug-97	Suspected UNSO HQ (frame 477)
62060810.NTF	305FB06206	10-Aug-97	Suspected UNSO HQ (frame 478)
62070810.NTF	305FB06207	10-Aug-97	Suspected UNSO HQ (frame 479)
62370810.NTF	305FB06237	10-Aug-97	Sukhumi Reservoir (frame 509)
62380810.NTF	305FB06238	10-Aug-97	Sukhumi Reservoir (frame 510)
62390810.NTF	305FB06239	10-Aug-97	Sukhumi Reservoir (frame 511)
62400810.NTF	305FB06240	10-Aug-97	Sukhumi Reservoir (frame 512)

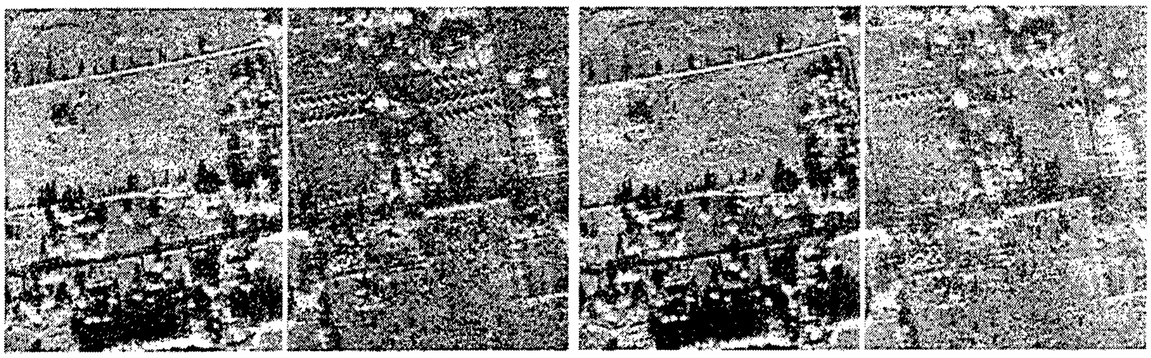
Maps

No localized maps are available.

Other Sources

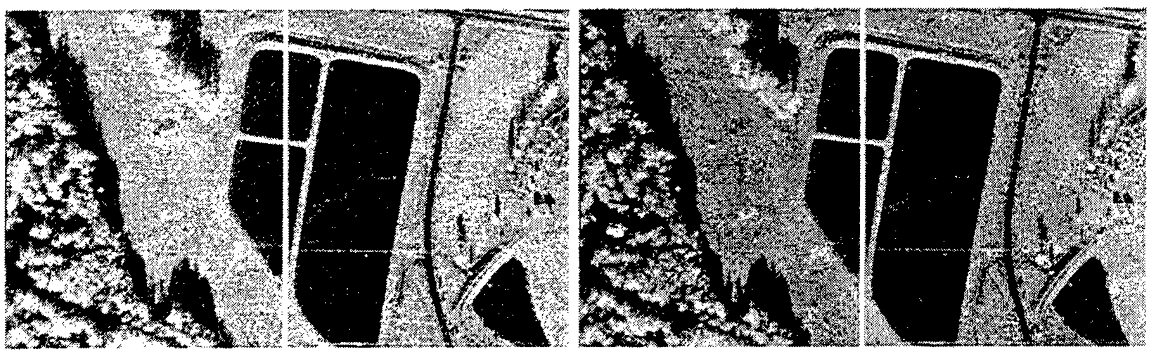
All available HUMINT and SIGINT sources suggest normal OB to be as follows:

Force	OB
UNSO paramilitary forces	4 X BMP-2
Russian 901st Motorized Rifle Regiment (Provisional)	10-20 X T-72 15-30 X BMP-2 10-20 X BTR-70



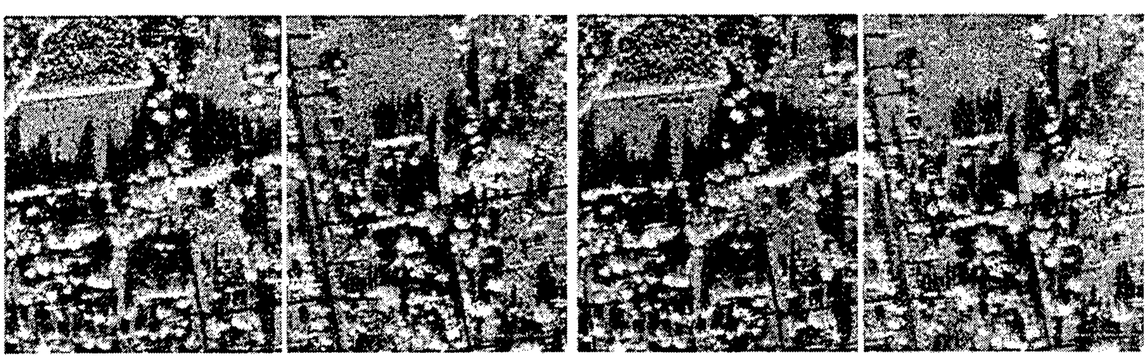
61810806 61820806 61810808 61820808

Garrison Area - 06 August Garrison Area - 08 August



62370801 62380801 62370810 62380810

Reservoir Area - 01 August Reservoir Area - 10 August



62060801 62070801 62060810 62070810

Suspected UNSO HQ - 01 August Suspected UNSO HQ - 10 August

Figure C-1. Some representative images from the exploitation exercise imagery set.

Note: the above images are not inclusive of the entire imagery set, but they represent the important subset of imagery where spatial and temporal changes may be detected.

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APPENDIX D: UTILITY AND USABILITY SURVEY

Utility and Usability Assessment of IA Workstation Features

Name________________________

Unit________________________

Experience (yrs)_______

Purpose: This survey is designed to elicit your input regarding the *utility* and *usability* of various features supported by image analyst workstations. Results will help researchers and developers identify which workstation tools / features are most useful and valuable to the image analyst, and 2) how these tools should be implemented such that they are easy to use.

Instructions: Listed on the following pages is a number of features available in various image analyst workstations. (No one system supports all of the features.) For each feature, you are asked to assign **two** ratings. The first rating is for the general *utility* of the feature. This means how <u>useful</u> you feel the given feature is to the image analyst. This assessment is for the feature in general, independent of how it is implemented with any given system. The second rating addresses *usability* of the feature. The usability rating you assign to a feature reflects your assessment of how <u>easily</u> a given feature is performed with a particular system.

If you are familiar with more than one particular workstation, you are asked to assess the usability of **each** workstation, with which you are familiar, for performing the given task. Please rate the features using the following scales.

Utility Rating Scale

5 = The feature is **essential** to the image analyst
4 = The feature is **very useful** to the image analyst
3 = The feature is **useful** to the image analyst
2 = The feature is **slightly useful** to the image analyst
1 = The feature is **useless** to the image analyst

Usability Rating Scale

5 = The usability of the feature as implemented is **excellent**
4 = The usability of the feature as implemented is **good**
3 = The usability of the feature as implemented is **fair**
2 = The usability of the feature as implemented is **poor**
1 = The usability of the feature as implemented is **extremely poor**

Functional Category	Function	Utility	Usabilty (by workstation) VITec ELT	Matrix	DIEPS 5D	ERDAS	Other ______
Organize Resources	Open/View multiple images simtaneously						
Gather Relevant Resources	Filter a list of files in a directory (i.e., list only files with a given character string in the filename or extension)						
Gather Relevant Resources	Query a database [internal or external] (e.g. search by BE #, lat/long,map region, installation name, equipment type etc.)						
Gather Relevant Resources	Identify images/reports associated with a given image						
Create Imagery Product	Link/associate support files to an image, object category, OB, etc.)						
Gather Relevant Resources	Import a file from an external database						
Create Imagery Product	Export (save) a file to an external database						
Create Imagery Product	Save a file in a different file format						
Gather Relevant Resources	Load multispectral imagery						
Create Imagery Product	Digitize an image (from external device e.g. scanner.)						
Gather Relevant Resources	Access a personal folder of IA support tools						
Gather Relevant Resources	Open a reference map for an image						
Create Imagery Product	Open an annotation overlay						
Review Tasking	Open a text file						
Create Text Product	Open a notepad						
Create Text Product	Autorecord Data (e.g. mensuration data) to the Notepad						
Create Imagery Product	Print a file						
Create Imagery Product	Print entire screen						
Create Imagery Product	"Burn In" Overlays (imbed overlay in image)						
Create Text Product	Edit File Header						
Gather Relevant Resources	Receive an NITF file (COMM function)						
Disseminate Reports	Transmit an NITF file (COMM function)						
Organize Resources	Specify image distribution						
Organize Resources	Create a mosaic						
Organize Resources	Cascade Multiple Windows						
Organize Resources	Tile Multiple Windows						
Organize Resources	Arrange Icons or Toolbars						
Organize Resources	Resize a window						
Create Imagery Product	Cut/Copy/Paste (Chip)an image region						
Create Imagery Product	Paste an image region to an annotation overlay						
Create Imagery Product	Crop an image						
Detect/Interpret Object	Rotate an image						
Detect/Interpret Object	Rotate to look angle or SAR up angle						
Detect/Interpret Object	Flip or "mirror" an image						
Detect/Interpret Object	Scale an image						
Organize Resources	Change the Aspect Ratio of an Image						
Detect/Interpret Object	Pan/Scroll/Roam through an image						
Detect/Interpret Object	Zoom in/out from a specified point in the image						
Organize Resources	Manipulate 2 images simultaneously						
Detect/Interpret Object	Vary contrast						
Detect/Interpret Object	Vary brightness						
Detect/Interpret Object	Vary saturation						

Detect/Interpret Object	Vary haze						
Detect/Interpret Object	Vary glare						
Detect/Interpret Object	Invert video (negative)						
Detect/Interpret Object	Convert Image to Gray Scale/RGB						
Detect/Interpret Object	Add pseudo color to a grayscale image						
Detect/Interpret Object	Filter image (vary sharpness, smoothness, edges)						
Detect/Interpret Object	Enhance SAR Image (e.g. streak removal)						
Detect/Interpret Object	Enhance Multispectral Imagery (e.g., terrain categorization, atmospheric correction)						
Detect/Interpret Object	Reset from ("undo") an Enhancement						
Detect/Interpret Object	View image histogram (grayscale)						
Detect/Interpret Object	View image histogram (RGB)						
Detect/Interpret Object	Manipulate image histogram						
Detect/Interpret Object	Match histogram of one image to another						
Create Imagery Product	Create line/shape objects e.g., arrows, rectangles, circles)						
Create Imagery Product	Draw freehand						
Create Imagery Product	Paint or Airbrush an Image						
Detect/Interpret Object	Mark lat/long of a point						
Create Imagery Product	Insert North up icon						
Detect/Interpret Object	Insert target symbol						
Detect/Interpret Object	Insert OB icons						
Detect/Interpret Object	Insert counting icon						
Create Imagery Product	Create new / edit annotation icons						
Create Imagery Product	Add Text/Label to a graphic						
Create Imagery Product	Select an object						
Create Imagery Product	Select multiple objects						
Create Imagery Product	Select all objects						
Create Imagery Product	Group multiple objects						
Create Imagery Product	Group objects in layers						
Create Imagery Product	Cut/copy/paste an annotation object						
Create Imagery Product	Delete an annotation object						
Create Imagery Product	Move object						
Create Imagery Product	Move object front/back in an image						
Create Imagery Product	Scale (resize) an Object						
Create Imagery Product	Rotate an Object						
Create Imagery Product	Change graphic's color/style						
Create Text Product	Change label color/style/font						
Create Text Product	Change label text						
Create Text Product	Record an object attribute (text description linked to an object)						
Detect/Interpret Object	View current cursor coordinates						
Detect/Interpret Object	Select units for cursor coordinates (e.g., pixels, lat/long, UTM)						
Detect/Interpret Object	Convert coordinates for a specified point (e.g. lat/long to UTM)						
Detect/Interpret Object	View a coordinate grid						
Organize Resources	See Overview of Entire Image (simultaneously with the working area of the image)						
Organize Resources	Fit entire image to the working area of the display						

Create Imagery Product	Turn on/off graphics						
Gather Relevant Resources	View File Header						
Gather Relevant Resources	Display any comments associated with an image (comments that are not part of image or overlay)						
Organize Resources	View image status/history						
Organize Resources	View images side by side or top and bottom						
Detect/Interpret Object	Flicker Between Images						
Organize Resources	Warp an Image to Fit Another						
Detect/Interpret Object	Merge (blend) images						
Detect/Interpret Object	View Image Through Porthole						
Organize Resources	Stereo Registration and Viewing (stereo image created from two images)						
Detect/Interpret Object	Measure length/distance						
Detect/Interpret Object	Measure height						
Detect/Interpret Object	Measure perimeter						
Detect/Interpret Object	Measure area						
Detect/Interpret Object	Identify bearing						
Detect/Interpret Object	Geolocate (given a known coordinate, locate the point in an image)						
Detect/Interpret Object	Location Mensuration (determine the coordinates of a given point)						
Detect/Interpret Object	Lat/Long Correction (adjust lat/long in image support data based on a known object/feature location)						
Detect/Interpret Object	View Accuracy Log (with estimated accuracy of mensuration results)						
Detect/Interpret Object	Count marked objects in an image						
Detect/Interpret Object	Automatic Target Recognition						
Detect/Interpret Object	Plot item (image, installation, etc.) on Map						
Detect/Interpret Object	Calibrate Lat/Long (for images without support data, specify lat/long of known objects and calibrate lat/long data for entire image)						
Detect/Interpret Object	Ground sample distance calibration (for images without support data, specify the size of a known object to determine pixel size and calibrate for entire image)						

Are there any exploitation functions or features not listed in this survey that you would like to see incorporated into future softcopy exploitation systems? If so, list them and briefly describe how each one might work.

Please list any other comments on existing exploitation systems or suggestions on how to improve future exploitation systems below.

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APPENDIX E: RESULTS OF UTILITY AND USABILITY SURVEY (ELT FEATURES SORTED BY UTILITY AND USABILITY)

Feature Category	Feature	Mean Utility	Max Usability	Workstation
Detect/Interpret Object	Geolocate (given a known coordinate, locate the point in an image)	5.00	5.00	CARS, IDEX
Detect/Interpret Object	Measure length/distance	5.00	5.00	IDEX
Detect/Interpret Object	Pan/Scroll/Roam through an image	5.00	5.00	CARS, IDEX, MET
Detect/Interpret Object	Zoom in/out from a specified point in the image	5.00	5.00	CARS, IDEX, MET
Create Imagery/Text Product	Select multiple objects	5.00	4.33	ERDAS
Create Imagery/Text Product	Select an object	5.00	4.17	VITec
Detect/Interpret Object	Convert coordinates for a specified point (e.g. lat/long to UTM)	4.83	5.00	CARS
Detect/Interpret Object	Flicker Between Images	4.83	5.00	CARS
Detect/Interpret Object	Location Mensuration (determine the coordinates of a given point)	4.83	5.00	CARS, IDEX, MET
Create Imagery/Text Product	Move object	4.83	4.00	CARS, DIEPS,ERDAS, IDEX, Matrix
Detect/Interpret Object	View current cursor coordinates	4.80	5.00	MET
Create Imagery/Text Product	Add Text/Label to a graphic	4.67	5.00	CARS
Create Imagery/Text Product	Delete an annotation object	4.67	5.00	CARS
Detect/Interpret Object	Identify bearing	4.67	5.00	IDEX
Organize Resources	Insert North up icon	4.67	5.00	CARS
Detect/Interpret Object	Mark lat/long of a point	4.67	5.00	CARS, IDEX
Detect/Interpret Object	Measure area	4.67	5.00	IDEX
Detect/Interpret Object	Measure height	4.67	5.00	CARS, IDEX
Detect/Interpret Object	Measure perimeter	4.67	5.00	CARS, IDEX
Gather Relevant Resources	Query a database [internal or external] (e.g. search by BE #, lat/long,map region, installation name, equipment type etc.)	4.67	5.00	CARS
Organize Resources	See Overview of Entire Image (simultaneously with the working area of the image)	4.67	5.00	CARS, IDEX
Organize Resources	Warp an Image to Fit Another	4.67	5.00	MET
Create Imagery/Text Product	Scale (resize) an Object	4.67	4.33	ERDAS
Organize Resources	View images side by side or top and bottom	4.67	4.00	ERDAS, MET
Organize Resources	Open/View multiple images simultaneously	4.60	5.00	CARS, IDEX
Create Imagery/Text Product	Create line/shape objects e.g., arrows, rectangles, circles)	4.50	5.00	CARS
Create Imagery/Text Product	Cut/Copy/Paste (Chip)an image region	4.50	5.00	MET
Organize Resources	Fit entire image to the working area of the display	4.50	5.00	Matrix, MET
Detect/Interpret Object	Rotate to look angle or SAR up angle	4.50	5.00	IDEX
Organize Resources	Select units for cursor coordinates (e.g., pixels, lat/long, UTM)	4.50	5.00	CARS
Organize Resources	Calibrate Lat/Long (for images without support data, specify lat/long of known objects and calibrate lat/long data for entire image)	4.50	4.50	CARS
Create Imagery/Text Product	Cut/copy/paste an annotation object	4.50	4.50	CARS
Gather Relevant Resources	View File Header	4.50	4.50	CARS
Create Imagery/Text Product	Change label text	4.50	4.00	ERDAS
Detect/Interpret Object	Automatic Target Recognition	4.40	4.50	CARS
Detect/Interpret Object	Filter image (vary sharpness, smoothness, edges)	4.33	5.00	IDEX, MET
Detect/Interpret Object	Lat/Long Correction (adjust lat/long in image support data based on a known object/feature location)	4.33	5.00	CARS, ERDAS, IDEX
Organize Resources	Manipulate 2 images simultaneously	4.33	5.00	MET
Detect/Interpret Object	Merge (blend) images	4.33	5.00	MET
Create Imagery/Text Product	Open an annotation overlay	4.33	5.00	CARS
Organize Resources	Plot item (image, installation, etc.) on Map	4.33	5.00	Matrix
Organize Resources	Resize a window	4.33	5.00	DIEPS

Create Imagery/Text Product	Turn on/off graphics	4.33	5.00	IDEX
Detect/Interpret Object	Vary brightness	4.33	5.00	IDEX, MET
Detect/Interpret Object	Vary contrast	4.33	5.00	IDEX, MET
Gather Relevant Resources	Identify images/reports associated with a given image	4.33	4.50	CARS
Create Imagery/Text Product	Rotate an Object	4.33	4.33	ERDAS
Create Imagery/Text Product	Change graphic's color/style	4.33	4.00	ERDAS
Create Imagery/Text Product	Change label color/style/font	4.33	4.00	ERDAS
Create Imagery/Text Product	Select all objects	4.33	3.60	VITec
Detect/Interpret Object	Scale an Image	4.20	4.00	DIEPS, Matrix
Create Imagery/Text Product	Export (save) a file to an external database	4.17	5.00	CARS
Gather Relevant Resources	Receive an NITF file (COMM function)	4.17	5.00	Matrix
Detect/Interpret Object	Reset from ('undo') an Enhancement	4.17	5.00	IDEX
Detect/Interpret Object	Rotate an Image	4.17	5.00	CARS, IDEX
Create Imagery/Text Product	Print a file	4.17	4.50	CARS
Disseminate Reports	Transmit an NITF file (COMM function)	4.17	4.50	ERDAS
Create Imagery/Text Product	Create new / edit annotation icons	4.17	4.00	CARS
Organize Resources	Ground sample distance calibration (for images without support data, specify the size of a known object to determine pixel size and calibrate for entire image)	4.17	4.00	ERDAS, Matrix, VITec
Create Imagery/Text Product	Group multiple objects	4.17	4.00	ERDAS
Create Imagery/Text Product	Save a file in a different file format	4.17	4.00	ERDAS
Gather Relevant Resources	Import a file from an external database	4.17	3.83	VITec
Detect/Interpret Object	View Accuracy Log (with estimated accuracy of mensuration results)	4.17	3.25	VITec
Detect/Interpret Object	Enhance SAR image (e.g. streak removal)	4.17	3.00	ERDAS, Matrix
Detect/Interpret Object	Count marked objects in an image	4.00	5.00	IDEX
Organize Resources	Create a mosaic	4.00	5.00	MET
Create Imagery/Text Product	Crop an Image	4.00	4.00	DIEPS, Matrix, VITec
Create Imagery/Text Product	Move object front/back in an image	4.00	4.00	ERDAS
Gather Relevant Resources	Display any comments associated with an image (comments that are not part of image or overlay)	4.00	3.75	VITec
Review Tasking	Open a text file	3.83	5.00	CARS
Create Imagery/Text Product	Draw freehand	3.83	4.33	ERDAS
Create Imagery/Text Product	Paste an image region to an annotation overlay	3.83	4.20	VITec
Create Imagery/Text Product	'Burn In' Overlays (imbed overlay in image)	3.83	4.00	ERDAS, IDEX
Organize Resources	Cascade Multiple Windows	3.83	4.00	ERDAS, MET
Gather Relevant Resources	Open a reference map for an image	3.83	3.50	ERDAS
Detect/Interpret Object	Vary haze	3.67	5.00	IDEX
Detect/Interpret Object	Vary saturation	3.67	5.00	IDEX
Organize Resources	Arrange Icons or Toolbars	3.67	4.50	CARS
Organize Resources	Specify image distribution	3.67	4.50	CARS
Gather Relevant Resources	Filter a list of files in a directory (i.e., list only files with a given character string in the filename or extension)	3.67	4.33	ERDAS
Detect/Interpret Object	Convert Image to Gray Scale/RGB	3.67	4.20	VITec
Create Imagery/Text Product	Edit File Header	3.67	4.00	Matrix
Create Imagery/Text Product	Group objects in layers	3.67	4.00	ERDAS
Create Imagery/Text Product	Link/associate support files to an image, object category, OB, etc.)	3.67	4.00	CARS, ERDAS
Organize Resources	Tile Multiple Windows	3.67	4.00	ERDAS, MET
Detect/Interpret Object	View a coordinate grid	3.67	4.00	ERDAS, Matrix, MET
Organize Resources	View image status/history	3.67	3.75	VITec
Create Imagery/Text Product	Print entire screen	3.50	5.00	CARS
Detect/Interpret Object	Vary glare	3.50	4.50	CARS
Detect/Interpret Object	Enhance Multispectral Imagery (e.g., terrain categorization, atmospheric correction)	3.50	4.33	ERDAS
Create Imagery/Text Product	Autorecord Data (e.g. mensuration data) to the Notepad	3.50	4.00	ERDAS, Matrix
Create Imagery/Text Product	Digitize an image (from external device e.g., scanner.)	3.50	4.00	ERDAS, IDEX

Detect/Interpret Object	Insert target symbol	3.50	4.00	ERDAS, IDEX
Detect/Interpret Object	Insert OB icons	3.33	5.00	IDEX
Detect/Interpret Object	Stereo Registration and Viewing (stereo image created from two images)	3.33	5.00	IDEX
Gather Relevant Resources	Load multispectral imagery	3.33	4.00	ERDAS
Create Imagery/Text Product	Record an object attribute (text description linked to an object)	3.33	4.00	ERDAS
Detect/Interpret Object	Insert counting icon	3.17	5.00	IDEX
Detect/Interpret Object	Invert video (negative)	3.17	4.00	IDEX
Create Imagery/Text Product	Open a notepad	3.17	4.00	Matrix
Detect/Interpret Object	Flip or 'mirror' an image	3.00	5.00	CARS
Organize Resources	Change the Aspect Ratio of an Image	3.00	3.00	ERDAS, VITec
Detect/Interpret Object	View Image Through Porthole	3.00	2.00	VITec
Detect/Interpret Object	Manipulate image histogram	2.83	5.00	MET
Create Imagery/Text Product	Paint or Airbrush an Image	2.83	4.17	VITec
Detect/Interpret Object	Add pseudo color to a grayscale image	2.83	4.00	ERDAS
Detect/Interpret Object	View image histogram (grayscale)	2.83	4.00	ERDAS
Detect/Interpret Object	View image histogram (RGB)	2.83	4.00	ERDAS
Detect/Interpret Object	Match histogram of one Image to another	2.67	5.00	MET
Gather Relevant Resources	Access a personal folder of IA support tools	2.67	4.00	ERDAS

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APPENDIX F: IMAGERY ANALYST WORKSTATION INTERFACE REQUIREMENTS SPECIFICATION

INTRODUCTION

This document describes the user interface requirements for an ELT system designed to support the Air Force intelligence mission through quick and effective imagery exploitation. The purpose of this system is to provide the Air Force imagery / intelligence analyst with the most effective toolset for the exploitation of all types of digital imagery.

Any user interface for an ELT system created to support the imagery exploitation mission should effectively support the three main areas of imagery exploitation, Orientation, Information Extraction, and Reporting. Orientation refers to the process by which the IA understands the problem or the questions that are being asked. It also includes understanding the capabilities and the limitations of the imagery for answering those questions. Information Extraction refers to the process of finding objects in and coming to conclusions about the imagery, consistent with the IA's tasking. Reporting refers to the process of compiling and disseminating conclusions drawn from the imagery in response to the tasking.

Based on the results of the Imagery / Intelligence Analyst Workstation Interface Analysis (to which this document is an appendix), a set of interface requirements was constructed.

GENERAL DESCRIPTION

Assuming that this ELT system would be implemented in a UNIX-based operating system environment, the overall style and 'look and feel' of the user interface should conform to the Motif style of X-Windows user interface wherever practical and appropriate.

The user interface should also offer as much flexibility in the creation, storage, and recall of individual user configurations. For example, if toolbars will be used for implementing quick access to frequently used features, the interface should allow a user to easily create and store sets of features that can be assigned to a toolbar or toolbars. These feature sets should be easy to recall, either in the form of 'pull-down' or 'drop-down' lists from which a set could be selected -- or even linked to a user's login act (e.g., in the case of a default configuration for a particular user, the system implements this configuration upon user login to the system without necessarily prompting the user.) This flexibility in configuration should be inherent at multiple levels. For example, the interface should allow a user to create higher level configurations based on multiple toolbar sets -- not simply feature sets assigned to particular toolbars.

The user interface should allow a user to assign contextual functionality to different controls as practical. For example, when using a zoom feature the user should be able to assign directionality of the zoom to different mouse buttons (e.g., 'zoom-in' with the left button and 'zoom-out' with the right, or vice versa). This functionality would only be available, however, while using the zoom feature unless otherwise specified by the user.

Because the user frequently shifts goal states (i.e., from orientation to information extraction to reporting, etc.), the interface should be designed so that these task shifts are accommodated as seamlessly as possible. In accordance with this philosophy, the interface should provide the user the capability to 'undo' and 'redo' as many operations as necessary. The user should also be provided with a historical display of the operations enacted and / or retracted and the ability to interact with

this display to command additional operations or groups of operations to be performed. For example, the system should keep a record of all user commanded operations. The user would have the capability to call up this record on a window separate from other working windows and then be able to select operations or sequences of operations from the record and apply those operations or operation sequences to any or all open images. The user should also have the capability to save these operations / operation sequences or groups of operations / operation sequences as individual entities so that the user has easy access to them.

The interface requirements specified in this document are referred to as interface *features*, and are organized by the exploitation process they tend to support most. Features that may support multiple processes will be listed only once.

SPECIFIC FEATURE REQUIREMENTS

Orientation Features

1.1. The user interface shall provide the capability to display any comments associated with an image (comments that are not part of image or overlay) and to edit those comments.

1.2. The user interface shall provide the capability to filter a list of files in a directory (i.e., list only files with a given character string in the filename or extension.)

1.3. The user interface shall provide the capability to identify images / reports associated with a given image.

1.4. The user interface shall provide the capability to import a file from an external database. The types of files available for import shall include NITF 2.X and 1.X, all widely used commercial image formats such as GIF, JPEG, TIFF, etc., all commercial and proprietary raster formats currently used by any DOD imagery exploitation organization, and ASCII text. Other text formats such as FrameMaker may be considered depending on their usage among the exploitation community.

1.5. The user interface shall provide the capability to load, open, and edit multispectral imagery. This feature should also include the ability to selectively include or exclude any spectral bands and to code each band as a particular user-selected or default color.

1.6. The user interface shall provide the capability to open a reference map for an image. Based on image coordinates inherent in the image file or on user-entered coordinates, the interface shall provide an outline and / or a reduced size / resolution version of the image superimposed on an 'oil stock' map image (if available) or vector drawn map in the appropriate location. An indication of location accuracy shall also be displayed.

1.7. The user interface shall provide the capability to query any available local or distributed database for reference text or image files relevant to the exploitation of mission imagery. This feature shall include the ability to search by various file associated data such as, Basic Encyclopedia (BE) number, latitude / longitude, installation name, equipment type, OB, keyword in a text report, or any other relevant identifier, by spatial information such as specifying a region on a spatial query map, by temporal information such as specifying a particular time frame of interest, or any combination of these methods.

1.8. The user interface shall provide the capability to receive NITF 2.X and 1.X files. This feature shall include the capability to immediately display any or all images as they are received or to defer display of images to a user-specified time and / or order.

1.9. The user interface shall provide the capability to view and edit file header and / or image header information. This feature shall also provide the capability to easily and intuitively associate these data with their respective files and / or images.

1.10. The user interface shall provide the capability to calibrate latitude / longitude (for images without support data, specify latitude / longitude of known objects and calibrate latitude / longitude data for entire image). The user will be able to select single points in an image and provide latitude and longitude values for these points. The system shall then interpolate and extrapolate the coordinates of the remaining points.

1.11. The user interface shall provide the capability to cascade and / or tile multiple windows according to the user's preference.

1.12. The user interface shall provide the capability to change the aspect ratio of an image. This feature shall be implemented by allowing the user to either indirectly change the ratio through the manual definition of a new aspect ratio (in a user-requested pop-up data entry box) or through direct manipulation by using the mouse / pointing device to grab a corner or edge of the image and drag it. The first method will require the display of the aspect ratio statically while the second method will require the display of the aspect ratio dynamically, or as it is changes while dragging an image edge or corner.

1.13. The user interface shall provide the capability to create a mosaic of multiple images. The mosaic should be able to be built either by manually tiling images next to each other or automatically by user's request. The automatic mosaic capability shall be driven by the availability of image coordinates in comparable or convertible geo-location coordinate systems. All open images that are being selected for automatic mosaicing that meet the previous geo-location coordinates requirements will be 'stitched' together in relative position to one another.

1.13.1 This feature shall also include the capability to geo-locate the mosaic unit on an electronic 'oil stock' map, if available, or on the appropriate vector-drawn map.

1.13.2 This feature shall also include the capability to save mosaics as image files or as associative units. That is, the user shall have the capability to name and save for future reference a mosaic as a new image (in any appropriate format), or as an association (much like an alias) between the composite images in the mosaic. This will allow the user to quickly and easily retrieve the mosaic while saving storage space, if necessary.

1.14. The user interface shall provide the capability to fit an entire image to the working area of the display. That is, an image, no matter the actual size and / or resolution shall be able to be opened so that the entire image completely fills the available viewing area of the display to the limit of the image's size. If an image at full resolution is physically smaller than the maximum viewing area, the image shall be opened at its maximum resolution.

1.15. The user interface shall provide the capability to perform ground sample distance calibration. That is, for images without support data, the user shall be able to specify the size of a known object in the image to determine pixel size and calibrate the entire image. This feature shall also provide the user an indication of the mensuration uncertainty introduced by this procedure

and the total estimated uncertainty in mensuration due to the combination of this procedure with all other known sources of error.

1.16. The user interface shall provide the capability to quickly and easily insert a north-up icon into an image. It is expected that orientation of the north-up icon will be automatic where geo-location coordinates are known (e.g., NITF format). This feature will alert the user when coordinates are not known that orientation must be performed manually, and will indicate where manual orientation is performed.

1.17. The user interface shall provide the capability to manipulate two images simultaneously

1.18. The user interface shall provide the capability to open / view multiple images simultaneously

1.19. The user interface shall provide the capability to plot an object (image, installation, etc.) on an electronic 'oil stock', if available, or a vector-drawn map. This feature will be available to the user when geo-location coordinates for the image and / or objects within the image are known.

1.20. The user interface shall provide the capability to resize a window by using the mouse / pointing device to select the window and to grab an edge or corner of the window and drag it to it's new location. More or less of the image in the window will then be in view depending on whether the edge or corner's new location is farther from or closer to the origin of the window, respectively.

1.21. The user interface shall provide the capability to see an overview thumbnail (a smaller, reduced resolution version of an image) simultaneously with the working area of the image. This feature shall be active when the current image cannot be entirely viewed in the working area of the image display because the working area of the image display is being shown at a higher zoom level than 100%. An indication of how much of the entire image the current working area of the display represents shall be required. An example of how this might be done is to provide a rectangular outline on the overview thumbnail that corresponds to what is currently being displayed in the image working area.

1.22. The user interface shall provide the capability to select units for cursor coordinates, such as pixels, latitude / longitude, and UTM. This shall require that the system be able to convert between coordinate systems at any time.

1.23. The user interface shall provide the capability to quickly and easily specify image distribution. That is, while the user is performing image-screening activities, the user shall have the capability to 'chip' out a sub-image of user-predefined size and transmit the chip into a predefined exploitation queue.

1.24. The user interface shall provide the capability to view image status / history

1.25. The user interface shall provide the capability to view images side by side and / or top and bottom. That is, for any two images that are being compared, the user shall be able to quickly and to easily specify whether images for comparison will be displayed horizontally or vertically.

1.26. The user interface shall provide the capability to warp an image to fit another. That is, the user will have the capability to specify points / pixels through direct manipulation on one image that correspond to the same number of points / pixels on another image. The system will then re-dimension the first image so that these points of correspondence match.

1.27. The user interface shall provide the capability to open, edit, and save a text file. The editing functions shall include the ability to cut, copy, and / or paste text through menu selections or keyboard shortcuts.

Information Extraction

2.1. The user interface shall provide the capability to apply pseudo color to a grayscale image.

2.2. The user interface shall provide automatic target recognition capability.

2.3. The user interface shall provide the capability to convert coordinates for a specified point (e.g. latitude / longitude to UTM).

2.4. The user interface shall provide the capability to convert image to grayscale / RGB.

2.5. The user interface shall provide the capability to count marked objects in an image.

2.6. The user interface shall provide the capability to enhance multispectral imagery (e.g., terrain categorization and atmospheric correction).

2.7. The user interface shall provide the capability to enhance SAR imagery (e.g. streak removal).

2.8. The user interface shall provide the capability to filter imagery (vary sharpness, smoothness, edges).

2.9. The user interface shall provide the capability to flicker between images.

2.10. The user interface shall provide the capability to flip or 'mirror' an image.

2.11. The user interface shall provide the capability to geo-locate (given a known coordinate, locate the point in an image).

2.12. The user interface shall provide the capability to identify bearing.

2.13. The user interface shall provide the capability to insert counting icons.

2.14. The user interface shall provide the capability to insert OB icons.

2.15. The user interface shall provide the capability to insert target symbols.

2.16. The user interface shall provide the capability to invert video (negative).

2.17. The user interface shall provide the capability to correct latitude / longitude (adjust latitude / longitude in image support data based on a known object / feature location).

2.18. The user interface shall provide location mensuration (determine the coordinates of a given point) capability.

2.19. The user interface shall provide the capability to manipulate image histograms.

2.20. The user interface shall provide the capability to mark latitude / longitude of a point.

2.21. The user interface shall provide the capability to match the histogram of one image to another.

2.22. The user interface shall provide the capability to measure area.

2.23. The user interface shall provide the capability to measure height.

2.24. The user interface shall provide the capability to measure length / distance.

2.25. The user interface shall provide the capability to measure perimeter.

2.26. The user interface shall provide the capability to merge (blend) images.

2.27. The user interface shall provide the capability to pan / scroll / roam through an image.

2.28. The user interface shall provide the capability to reset from ('undo') an enhancement.

2.29. The user interface shall provide the capability to rotate an image.

2.30. The user interface shall provide the capability to rotate to look angle or SAR up angle.

2.31. The user interface shall provide the capability to scale an image.

2.32. The user interface shall provide the capability for stereo registration and viewing (stereo image created from two images).

2.33. The user interface shall provide the capability to vary brightness.

2.34. The user interface shall provide the capability to vary contrast.

2.35. The user interface shall provide the capability to vary glare.

2.36. The user interface shall provide the capability to vary haze.

2.37. The user interface shall provide the capability to vary saturation.

2.38. The user interface shall provide the capability to view a coordinate grid.

2.39. The user interface shall provide the capability to view an accuracy log (with estimated accuracy of mensuration results).

2.40. The user interface shall provide the capability to view current cursor coordinates.

2.41. The user interface shall provide the capability to view image histograms (grayscale).

2.42. The user interface shall provide the capability to view image histograms (RGB).

2.43. The user interface shall provide the capability to view an image through a porthole.

2.44. The user interface shall provide the capability to zoom in / out from a specified point in the image.

Reporting

3.1. The user interface shall provide the capability to 'Burn In' Overlays (imbed an overlay in image).

3.2. The user interface shall provide the capability to add text / label to a graphic.

3.3. The user interface shall provide the capability to auto-record data (e.g., mensuration data) to the Notepad.

3.4. The user interface shall provide the capability to change a graphic's color / style.

3.5. The user interface shall provide the capability to change label color / style / font.

3.6. The user interface shall provide the capability to change label text.

3.7. The user interface shall provide the capability to create line / shape objects (e.g., arrows, rectangles, and circles).

3.8. The user interface shall provide the capability to create new / edit annotation icons.

3.9. The user interface shall provide the capability to crop an image.

3.10. The user interface shall provide the capability to cut / copy / paste (chip) an image region.

3.11. The user interface shall provide the capability to cut / copy / paste an annotation object.

3.12. The user interface shall provide the capability to delete an annotation object.

3.13. The user interface shall provide the capability to digitize an image using an external device (e.g., scanner).

3.14. The user interface shall provide the capability to draw freehand.

3.15. The user interface shall provide the capability to edit file headers.

3.16. The user interface shall provide the capability to export (save) a file to an external database.

3.17. The user interface shall provide the capability to group objects in layers.

3.18. The user interface shall provide the capability to group multiple objects.

3.19. The user interface shall provide the capability to link / associate support files to an image (object category, OB, etc.).

3.20. The user interface shall provide the capability to move an object.

3.21. The user interface shall provide the capability to move an object forward / backward in an image.

3.22. The user interface shall provide the capability to open a notepad.

3.23. The user interface shall provide the capability to open an annotation overlay.

3.24. The user interface shall provide the capability to paint or airbrush an image.

3.25. The user interface shall provide the capability to paste an image region to an annotation overlay.

3.26. The user interface shall provide the capability to print a file.

3.27. The user interface shall provide the capability to print the entire screen.

3.28. The user interface shall provide the capability to record an object attribute (i.e., text description linked to an object).

3.29. The user interface shall provide the capability to rotate an object.

3.30. The user interface shall provide the capability to save a file in a different file format.

3.31. The user interface shall provide the capability to scale (resize) an object.

3.32. The user interface shall provide the capability to select all objects.

3.33. The user interface shall provide the capability to select an object.

3.34. The user interface shall provide the capability to select multiple objects.

3.35. The user interface shall provide the capability to toggle on / off graphics.

3.36. The user interface shall provide the capability to transmit an NITF file.